

A Political Economy of Access



Infrastructure, Networks,
Cities, and Institutions

David M. Levinson

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A POLITICAL
ECONOMY
OF ACCESS:

INFRASTRUCTURE, NETWORKS,
CITIES, AND INSTITUTIONS

NETWORK DESIGN LAB

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First printing, February 2019

The book was prepared in part using Overleaf.

The cover shows *The Rebecca Riots* from the UK National Gallery <https://www.nationalarchives.gov.uk/education/resources/rebecca-riots/>. Originally published in *Illustrated London News* (1843).

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Dedication

This book is dedicated to our families, who tolerated us spending much time in front of computers writing this instead of engaging in direct human interaction.

Preface

We don't want to come across as *David Downers*,¹ but it is hard to examine the state of American transport and land use planning without a large dose of cynicism about motives, and skepticism about claims and priorities.

Transport engineering and land use planning are technical fields nominally grounded in rational thought. Yet level-headed analysis and calculations haven't led to healthy and financially sustainable transport and land use systems. Part of what we see as the problem is a focus on *mobility* over *accessibility*. This focus prioritizes vehicular flows and speed over people and proximity. Our shared goals should not be how to maximize how much people and things travel about. Rather, our goals should be about how can society make it as easy as possible to reach opportunities and activities. A second part of the problem is privileging *expansion* over *preservation*. In a world where transport is new with few roads and no transit service, expansion is the critical phase of development; but in today's world of mature networks, preservation is so much more important. We identify numerous problems, but the solutions are difficult to implement. That is not, we believe, because they are not good ideas, but rather because the *institutions* that make decisions are incapable of implementing them.

This book is called *A Political Economy of Access* for a reason. Our political economy analysis explains how access is shaped by law, culture, and governance. The issues we raise are not new, either. It was a century ago when Frederick Law Olmstead, Jr. said:

There has been a decided tendency on the part of official street planning to insist with quite needless and undesirable rigidity upon fixed standards of width and arrangement in regard to purely local streets, leading inevitably in many cases to the formation of blocks and lots of a size and shape ill adapted to the local uses to which they need to be put.²

¹The phrase 'Debbie Downer' refers to someone whose negative attitude depresses or discourages others.

² (Olmsted 1910).

This quote introduces many of our concerns. First, streets and road networks are more than just thoroughfares. They actively

shape the location and function of the built environment, support or deter alternatives to automobility and substantially affect public safety. Second, in a system where transport networks and land regulations are designed and built separately, there are mismatched incentives. The most efficient road may contradict the needs of great places. Speed is not necessarily a characteristic of great cities – other than maybe Indianapolis, no city brags about being a raceway. Third, rigid roadway design is a hallmark of a focus on mobility. The road itself is simply a conduit through which one passes, and the quality of destinations is diminished. Lastly, these are just some of the well-known problems that have persisted a century later, yet we have spent far less effort trying to understand why we keep building cities that many consider undesirable.

An additional issue is that transport systems require coordination across actors. The car you own is worthless without roads, and the capital and expertise required to build and maintain cars very much differs from the expertise needed for roads. Certainly, some self-contained transport systems exist, such as elevators or airport trams, but these do not scale to cities overall. The question remains how to integrate infrastructure, traffic flow, and land development. This book advocates for coordination through prices, so people can account for the full cost of the actions of themselves and others when making decisions, whether as a traveler, developer, planner, or elected official.

The current state of transport and land use systems raises further concerns. New technologies are changing transport in fundamental ways. App-based services offer new taxi-type alternatives, which compete with and complement existing travel modes. These services are backed by deep-pocketed investors and despite their popularity are, as of this writing, not actually profitable.³ But there is little doubt that such services will persist in some form once the money runs out. If the history of taxicabs is any guide, a new era of regulation will protect Uber, Lyft, and others from their demise.

Private firms have reoriented transport planning priorities, for good and bad. Not long ago long-range transport plans largely set the course for policy and investment decades ahead. Now everything from streetcars for real estate development to ridesharing through dockless bikesharing and, the flavor of the week, electric scooters, are undermining the slow predictability of policy. With automated vehicles peeking over the horizon, the conventional approach to transport planning may be obsolete as no one knows what innovations and unintended side effects automation will bring.

³ These firms might not be actually as popular as their inflated valuations suggest, either. The US Bureau of Labor Statistics shows the gig economy had fewer workers in 2017 than 2016, and the 2017 National Household Travel Survey shows that fewer than one-half of one percent of trips are by taxi or app-based service nationally.

In early 2018 electric scooters were introduced in a dozen cities in the US. As of this writing we don't know if these will even exist when you read this, will be ubiquitous, or if they will be replaced by yet another novel mode of transport like motorized rollerblades or heeies (shoes with wheels in them).

The internal combustion engine is likely nearing the end of its century of dominance, as well, to be replaced by electric drivetrains. This is a much bigger issue than just a propulsion system. These engines use fuel, which is taxed to pay for infrastructure across the US and in some other countries, and taxed for general revenue elsewhere. A shift to electricity affects the core relationship between user fees and public spending. New sources of revenue will have to be developed, including road tolls, road access charges, parking fees, and other sources. Of course, a loss of motor fuel taxes also will affect who pays for infrastructure. The role of the federal government (at least in the United States) will likely diminish as federal fuel taxes decline. This devolution of authority (which is happening in Western countries) pushes local and state or provincial governments to raise their own revenues. Voters will be asked to approve new taxes and fees, which introduces many concerns, including whether voters are adequately informed to assess the value of any package of taxes and spending.⁴

Transport referenda are generally popular with the public as more than 70 percent usually pass in the United States. But voters often don't know the true details of what they are voting on. California has led the way in voter-led projects, including their high-speed rail (HSR) project that voters passed with 52.6% of the votes in 2008.⁵ This despite well-publicized concerns, proponents promised a train that would connect the state, "[C]arrying up to 117 million passengers annually by 2030, with the capacity to also carry high-value, lightweight freight."⁶ Since then, the timeline has been extended, the scope scaled back, forecast recanted, and the costs have increased dramatically – at one point to nearly \$100 billion. Stations have been delayed or cancelled, and now the train is promoted as a commuter service to open up housing markets away from the extremely expensive coastal cities. The project is substantially different from what voters were sold, and a very passive aggressive solution to the state's housing affordability crisis. We expect more projects like this.

Lastly, the political economy of access must address issues of race and social justice. New transit investments tend to favor wealthier, whiter communities. Bicycle advocacy is dominated by young, white men,⁷ as are the technology companies developing micromobility services and microtransit and taxi apps. As once young, white men ourselves, there is nothing wrong with that, but we have learned it is but one perspective of many. Access to new systems raises privacy concerns (though most people don't really act like they care about privacy – see Facebook behavior, for instance, where people willingly

⁴ There is also concern about how many people actually vote. In the US voting is voluntary and about half of eligible voters actually cast ballots for federal elections, turnout is much lower for local races. Australia has compulsory voting and regularly has voter turnout of over 90 percent.

⁵ California Proposition 1A approved the issuance of \$9.95 billion of general obligation bonds to help fund an 800 *mi* (1300 *km*) high-speed train under the supervision of the California High-Speed Rail Authority. In 2019, Governor Newsom conceded the project only has funding to complete a section in the Central Valley from Bakersfield to Merced (Lazo 2019). Beyond that the future of the project is unclear.

⁶ (California High-Speed Rail Authority 2008).

⁷ (Hoffmann 2016).

share all kinds of details about their lives seemingly unconcerned about how those data are used).

Through this book, the value we wish to promote is access. Access is the ability for people and firms to interact, whether through employment, production, consumption or sales. As we explain in the next chapters, access is a value that differs from mobility. Where mobility improvements are a hallmark of recent decades of transport policy, our focus on mobility has led to auto dominated infrastructure that offers few other options about how to get around. With a focus on access, we can orient transport policy to connecting people to places they want to be rather than accommodating driving at the expense of everything else.

So why should you read another book about transport and land use policy? (Especially since one of us has already written on this topic?)⁸ This book differs in that we won't focus on empirical arguments – we present political arguments. We argue the political aspects of transport policy shouldn't be assumed away or treated as a nuisance. Political choices are the core reasons our cities look and function the way they do. There is no original sin that we can undo that will lead to utopian visions of urban life.

As Americans,⁹ we give extra attention to the US – which in our view trails the developed world in the quality of its transport and land use systems, but take many examples from outside the US to illustrate why the problems in the US are political, and not structurally embedded in the nature of transport or land use, and thus solvable.

The book begins by introducing and expanding on the idea of Accessibility. Then we proceed through several major parts: [Infrastructure Preservation](#),¹⁰ [Network Expansion](#),¹¹ [Cities](#),¹² and [Institutions](#).¹³ Infrastructure preservation concerns the relatively short-run issues of how to maintain and operate the existing surface transport system (roads and transit). Network expansion in contrast is a long-run problem, how to enlarge the network, or rather, why enlarging the network is now so difficult. Cities examines how we organize, regulate, and expand our cities to address the failures of transport policy, and falls into the time-frame of the very long-run, as property rights and land uses are often stickier than the concrete of the network is durable. In the part on Institutions we consider things that might at first blush appear to be short-run and malleable, are in fact very long-run. Institutions seem to outlast the infrastructure they manage.

Many of the transport and land use problems we want to solve already have technical solutions. What these problems don't have,

⁸ See (Garrison and Levinson 2014; Levinson 2002; Levinson and Krizek 2017).

⁹ Though David Levinson currently lives in Australia.

¹⁰ §I.

¹¹ §II.

¹² §III.

¹³ §IV.

and what we hope to contribute, are political solutions. We expect the audience for this book to be practitioners, planners, engineers, advocates, urbanists, students of transport, and fellow academics. While we may come across as overly critical at times, we write in the spirit of improving transport and land use policy through a focus on access. Since accessibility is what we think is important, and wish to promote, we argue for and are willing to accept trade-offs that advocates of more building or a particular travel mode may not.

Acknowledgements

We thank the following for their patient and thorough reviews of earlier drafts of the manuscript: T.F. Carpenter, Ahmed El-Geneidy, Jonathan Gifford, Anson Gock, Eric Goldwyn, Cameron Gordon, Bern Grush, Derek Halden, Soren Have, Jason Hawkins, Huê-Tâm Webb Jamme, Kevin Krizek, Bahman Lahoorpoor, Michael Manville, Andrew Mondschein, and Somwrita Sarkar.

Elements of the book have appeared in earlier form in our blogs: *The Transportist*,¹⁴ *streets.mn*,¹⁵ and *Getting from here to there*.¹⁶ Parts have been supported by and appeared in reports and articles for the Brookings Institution,¹⁷ *Business Insider*,¹⁸ *Citylab*,¹⁹ the Conservative Reform Network,²⁰ Reason Foundation,²¹ and the Van Alen Institute,²²

The text is the fourth volume in the *Access* series, and complements David Levinson's *The End of Traffic and the Future of Access*²³ (with Kevin Krizek), *Spontaneous Access*,²⁴ and *Elements of Access* (with Wes Marshall and Kay Axhausen).²⁵

As always, all errors remain the responsibility of the authors.

¹⁴ <http://transportist.org>.

¹⁵ <http://streets.mn>.

¹⁶ <http://davidaking.blogspot.com>.

¹⁷ (Levinson and Istrate 2011; Kahn and Levinson 2011).

¹⁸ (Levinson and King 2013).

¹⁹ (Levinson 2014).

²⁰ (Levinson 2015b).

²¹ (Levinson 2012).

²² (Levinson 2017).

²³ (Levinson and Krizek 2018).

²⁴ (Levinson 2016b).

²⁵ (Levinson et al. 2018).

1

Accessibility



Figure 1.1: Eighteenth century print of the Hyde Park Turnpike toll gate, London.

According to the system of natural liberty, the sovereign¹ has only three duties to attend to ...

First, the duty of protecting the society from violence and invasion

...

secondly, the duty of protecting, as far as possible, every member of society from the injustice or oppression of every other member of it ... and,

thirdly, the duty of erecting and maintaining certain public works and certain public institutions, which it can never be for the interest of any individual, or small number of individuals, to erect and maintain; because the profit would never repay the expense to any individual or small number of individuals, though it may frequently do much more than repay it to a great society. – Adam Smith

¹ The 'sovereign' here means the political leader.

1.1 *The duty of the sovereign*

² The quotes in this chapter are from (Smith 1776). See also Metschies (2001) for further discussion of Adam Smith's comments on transport.

In his 1776 book *Wealth of Nations*, Adam Smith² puts his finger on a number of buttons. He identifies three “Duties of the Sovereign,” shown in the opening quote, the most relevant of which is the third, concerning “erecting and maintaining certain public works.”

ACCESS IS SOCIALLY PRODUCED. Public works like roads reduced travel time by reducing distances and by increasing speeds. This is the mobility half of the accessibility problem. In western countries transport networks are regulated or owned by the public sector, which has assumed the role of Smith's ‘sovereign.’ The other half of accessibility is what can be reached. This is the activity that takes place on land. In western countries, this is largely in the hands of the private sector.³ A developer not only gains value for himself by developing, but also increases access for everyone else.

³ Governments regulate land development and thus can influence access on this half as well.

⁴ §1.2.

⁵ §1.3.

⁶ §1.4.

This chapter introduces access as efficiency⁴ and access as equity⁵ in sequence before turning to the motivation⁶ for the book.

1.2 *Access as efficiency*

Good roads, canals, and navigable rivers, by diminishing the expense of carriage, put the remote parts of the country more nearly upon a level with those in the neighbourhood of the town. They are upon that account the greatest of all improvements. They encourage the cultivation of the remote, which must always be the most extensive circle of the country. They are advantageous to the town, by breaking down the monopoly of the country in its neighbourhood. They are advantageous even to that part of the country. Though they introduce some rival commodities into the old market, they open many new markets to its produce. Monopoly, besides, is a great enemy to good management, which can never be universally established but in consequence of that free and universal competition which forces everybody to have recourse to it for the sake of self-defence. It is not more than fifty years ago that some of the counties in the neighbourhood of London petitioned the Parliament against the extension of the turnpike roads into the remoter counties. Those remoter counties, they pretended, from the cheapness of labour, would be able to sell their grass and corn cheaper in the London market than themselves, and would thereby reduce their rents, and ruin their cultivation. Their rents, however, have risen, and their cultivation has been improved since that time. – Adam Smith

Smith's quote, from Chapter 11 of *Wealth of Nations*, notes how transport (roads and canals in his day) created value. While his view was largely agrarian and shaped by seasonal shipments of commodities, the logic applies to contemporary metropolitan

regions and their daily flows of goods and labor. Transport creates value because it extends the market, and thus increases the division of labor, specialization, and economies of scale.

In cities, firms aim to exploit economies of agglomeration and improve productivity and output by locating near customers, workers, suppliers, and even competitors, while trying to reduce the combined costs of land and travel. Individuals and families aim to achieve proximity to their work, shops, and other activities and amenities while simultaneously obtaining more house and lot for the money. This tension between centralizing and decentralizing forces keeps the city from collapsing into a black hole or flying apart at the edges. However, the balance between these two forces changes over time as technology, demographics, socio-economics, and other preferences change. In recent decades, these changes have led to many US cities becoming larger in population, but larger still in area.⁷

⁷ (Marshall 2007).

As firms choose locations, they select metropolitan regions to be near activities, things, organizations, and people they find important, and select locations within metropolitan areas for similar reasons, trading off benefits and costs of those locations. Residents are no different. Location choice is a set of trade-offs. Those trade-offs depend on the location pattern given by placement of other activities, and the transport networks used to reach them. Transport networks, often publicly provided, convey value to land by enabling access to key activities.

People are willing to pay more for locations with better locations where more activities can be easily reached.⁸ Streets, highways, and transit systems, however, are not free. Further, the resources provided to support transport have diminished in real terms in the United States,⁹ leading to a degradation in quality. This reduces their value as people will avoid traveling on bad roads or decrepit buses. However, capturing the property value created by access to destinations provided by transport networks, and using that captured value to invest in the operations, maintenance, and in some cases expansion of those networks is a win-win solution waiting to be reached. We think of this as a virtuous cycle: infrastructure creates access, access creates value, value can be captured, and captured value can fund infrastructure, an idea we elaborate in [value capture](#).¹⁰

⁸ (Iacono and Levinson 2017).

⁹ (Pew Charitable Trusts 2014) (Figure 7).

¹⁰ §16.

THE DIVISION OF LABOR IS LIMITED BY ACCESSIBILITY

As it is the power of exchanging that gives occasion to *the division of labour*, so the extent of this division *must always be limited by* the extent

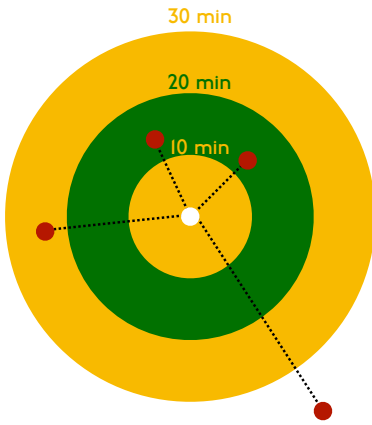


Figure 1.2: Cumulative opportunity accessibility. No jobs are available in less than 10 minutes, 2 jobs within 20 minutes, and 1 additional job within 30 minutes.

¹¹ The most commonly used accessibility measure (Hansen 1959) is given below.

$$A_i = \sum_{j=1}^I O_j f(C_{ij}) \quad (1.1)$$

To apply this in practice, the function of costs needs to be specified. For simplicity we present the cumulative opportunities formulation. The idea is illustrated in Figure 1.2.

$$f(C_{ij}) = \begin{cases} 1 & \text{if } C_{ij} < t \\ 0 & \text{if } C_{ij} \geq t \end{cases} \quad (1.2)$$

where: A_i is access at point i , O_j are the opportunities at point j , C_{ij} is the cost of travel between i and j , and f is a function that transforms costs.

¹² The concept has been well-described in the literature, and there are numerous definitions (Handy and Niemeier 1997; Kwan and Weber 2003; Geurs and Van Wee 2004; Scott and Horner 2008; Ottensmann and Lindsey 2008).

¹³ Travel time index (TTI) is given by:

$$TTI = \frac{t_c}{t_f}$$

where:

t_c is the congested travel time and

t_f is the freeflow travel time.

¹⁴ 250,950 mi^2 .

¹⁵ (Health Information Management Branch 2008).

¹⁶ 33.77 mi^2 .

of that power, or, in other words, by *the extent of the market*. When the market is very small, no person can have any encouragement to dedicate himself entirely to one employment, for want of the power to exchange all that surplus part of the produce of his own labour, which is over and above his own consumption, for such parts of the produce of other men's labour as he has occasion for. – Adam Smith

The bigger the market, the more specialized producers can be. And the bigness of the market depends on transport (how far you can reach) as well the intensity with which space is used (density of activity). In modern language, Smith observed that the size of the economy depends on accessibility.¹¹

Accessibility measures the efficiency of the city in its primary role: enabling people to reach other people, places, and things. In short, *accessibility is the ease of reaching valued destinations*.¹² A place that is accessible is easily reached. A place that has high accessibility is a great jumping off point to go elsewhere quickly. The places that we value are varied, but typically include work, shop, school, entertainment, and recreation. Firms value access to suppliers, labor talent, and their end markets.

MOBILITY VERSUS ACCESSIBILITY. Those not steeped in the jargon (and some who are) often conflate mobility and accessibility. Mobility measures the ease of moving on the network, and is often captured by network speed or the travel time index (the ratio of actual (congested) travel time to the best possible, or freeflow time),¹³ a standard way of defining congestion across networks. Yet mobility only addresses half the problem, movement on the network. It does not address where people are going. A simple example illustrates the problem with considering only mobility.

Compare Manhattan and Manitoba. In Manitoba there is a high network speed, there is virtually no congestion, and a travel time index of approximately 1. The population of Manitoba, an area of 649,950 km^2 ,¹⁴ is almost 1.2 million people,¹⁵ of which about three out of four live in metropolitan Winnipeg. In contrast consider the island of Manhattan, an area of 61.56 km^2 ,¹⁶ (over 19,000 Manhattans could fit in Manitoba) and a resident (night-time) population of 1.6 million. Clearly the island is heavily congested, it takes a relatively long time to travel a given distance. The travel time index for New York City as a whole is 1.37, among the top five cities in the US. Manhattan alone would be higher still. This means it takes about 37% longer to travel with traffic than without, and of course the freeflow speeds are lower in Manhattan than Manitoba. But because the population and employment are so high, there are many more destinations one can reach in the same amount of time.

In a half-hour drive from the center of Manhattan, one can reach millions of jobs.

From the densest part of Manitoba, the center of Winnipeg, one could reach about 400,000 jobs. Manhattan is roughly 10 times as accessible as Winnipeg despite speeds that are at best half as fast. Compared to a random point in Manitoba, it is thousands of times more accessible. This value is reflected in land prices.¹⁷ The difference in rent is not as great as the difference in accessibility, but that is due to the cost of the structure itself (as opposed to the land) which is largely fixed (though still may be higher in New York than the Prairie Provinces).

The transport problem is often posed as a mobility problem, for instance: How can we move quickly on networks? Concerns about congestion are often brought to the fore.¹⁸ Hyperbolic words like ‘gridlock’¹⁹ are often thrown around in the media, though literal gridlock, as shown in Figure 1.3 is uncommon.

A widely cited study finds that congestion in the Twin Cities region increased from 1995 to 2005, with annual delay per peak traveler rising from 31 to 43 *hours/year*.²⁰ In contrast, another study²¹ finds the same Twin Cities region was more accessible in 2005 than 1995, more jobs could be reached in the same amount of time despite the rise in congestion.

How can we explain these two seemingly divergent outcomes? There are several possibilities. On the mobility side these relate to additional roadway capacity and more intense use of faster roads in 2005 and 1995. On the land use side, these relate to the relative location of jobs and housing. Starting on the mobility side, it is possible that average network speed can rise as does congestion. Table 1.1 illustrates this.

In this example, the average speed before was 28 *km/h*.²² The speed drops on both links, yet, in the after case, the system average speed has risen to 30. This is because the share of travelers on each link has changed. This example illustrates what happens manifold as more and more travelers (and more importantly, a greater share of travelers) switch to faster suburban highways from congested

¹⁷ As of 2010, monthly rents in Midtown Manhattan were just under \$645/*m*² (\$60/*ft*²). In Winnipeg rents were about \$150/*m*² (\$14/*ft*²). The rent in Winnipeg is in Canadian dollars, the exchange rate varies.

¹⁸ The Urban Mobility Indicators report is the most widely cited of these reports (Schrank and Lomax 2009).

¹⁹ The term gridlock was popularized by transport engineer Sam Schwartz, who used it during a transit strike in 1980 to describe conditions. The earliest use of the term to describe traffic was the early 1970s.

²⁰ (Schrank and Lomax 2009).

²¹ (Levinson et al. 2017).

²² 17 *mph*. The units don’t actually matter.

		Link 1	Link 2
Speed (<i>km/h</i>)	Before	55	25
	After	40	20
Flow (Share of traffic)	Before	10%	90%
	After	50%	50%

Table 1.1: Example: Two Facility System. Adapted from Levinson and Kumar (1994b).

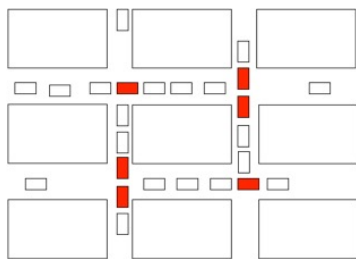


Figure 1.3: Stylized image of Gridlock.

urban arterials. While both roads got worse, the relatively faster route attracted more travelers.

So why would the share of travelers using each link change? The decentralization of employment, which grew in the suburban ring while being essentially static in the center city, is the driving force behind these seeming paradoxes of higher travel speeds despite higher congestion, and more importantly, greater accessibility despite rising congestion. Moreover, there were small changes in relative residential location – this period saw the number of people residing in downtown Minneapolis increase from approximately zero to about 30,000 – clearly more of the region’s new residents moved into suburban locations. This convergence of accessibility (or flattening of the city) is illustrated by improved job/worker balance as shown in Figure 12.2, and indicates that locators (especially employers) respond to accessibility determined by network configuration and pre-existing land use (especially residential) to site their own organizations in a way to keep transport costs for their workers in check (and thus reduce the wage required to attract good employees).

MOBILITY COMPLEMENTS ACCESSIBILITY. Mobility-focused transport policies are not the enemy of accessibility-focused policies. Mobility improvements can complement accessibility. For governments, it is a matter of understanding the trade-offs between density and mobility, which affects overall accessibility. Figure 1.4 has a y-axis as density, and x-axis as mobility, where the Northeast corner would be high access: high density multiplied by high mobility.

This system behaves differently by mode. For transit networks, cities arrange themselves on a line from the southwest to the northeast (a positive feedback loop between supply and demand). For auto networks, cities arrange on a line from the southeast to the northwest (a negative feedback loop between congestion and demand). Using data one could place specific cities on the graph. One expects places like New York and Hong Kong in the northeast corner, most US cities in the southeast corner, small developing-world cities without widespread adoption of modern automobile or transit technology in the southwest corner. Poor, but dense cities without good transport networks lie in the upper northwest corner.

Accessibility is an [economic good](#),²³ but it is not a good without costs such as congestion, and there are limits to how much people are willing to pay for access. It may also suffer from diminishing

²³ §A.

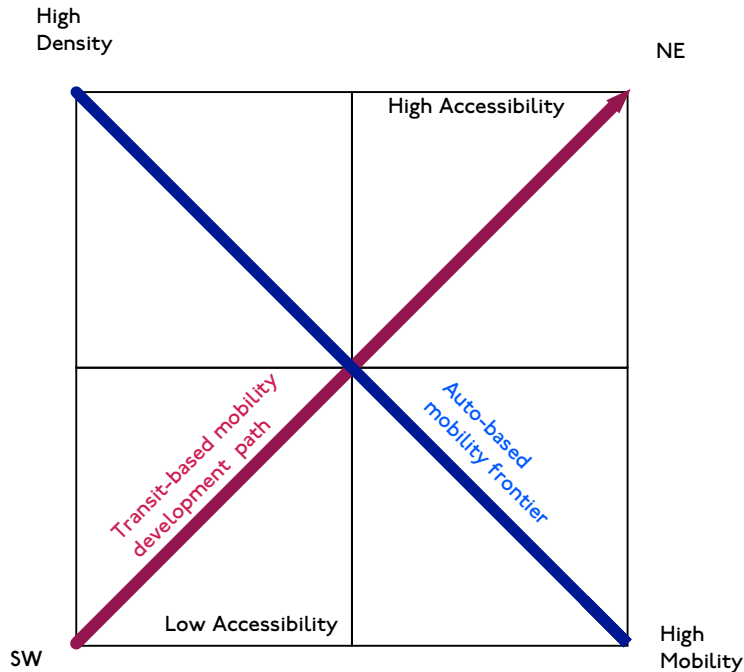


Figure 1.4: Density Mobility Tradeoff.

returns, where beyond a point each additional unit of accessibility is worth less and less.

1.3 Access as equity

If we agree that more access is generally better than less access, especially after accounting for all the benefits and all the costs associated with access, then we want our transport - land use systems to efficiently produce access. The more efficiently we produce access, the more access we can have per dollar spent. Of course, access per dollar is but one measure of efficiency. To maximize access provided per dollar, only the investments that carry very high access per dollar returns should be pursued. This would result in smaller networks than we have now. Hong Kong is built around this principle in many respects, where the transit owner and operator is also a real estate developer, so transit and land for development are constrained to ensure high densities and lots of ridership. From an efficiency perspective, this works well, and people travel from around the world to marvel at how well the Rail + Property model works. But Hong Kong is also consistently ranked as the least affordable city in the world.²⁴

²⁴ (US Department of Housing and Urban Development 2018).

Equity is also an important objective. In an absolute sense, there is a trade-off between efficiency and equity. The most economically efficient investments from a social productivity sense do not necessarily benefit the least well-off, and certainly don't benefit everyone equally. For instance, it is clear that rich people have a higher economic value of time than poor people in the conventional ways of measuring such things, which depend on willingness to pay to save time. Investing public funds to reduce the travel time of wealthy people (which increases their accessibility) tends to pencil out²⁵ more than investing those funds for poor people. Departments of Transportation, with their political leadership, insist that value of time for all individuals making a particular kind of trip be considered equal in evaluations.²⁶ This is an assumption to support equity over efficiency. While we can argue that our measures of efficiency and productivity are broken, we do so primarily because we do not like the implications of the outcomes.

²⁵ By *pencil out* we mean expected benefits from time savings exceed costs required for investment.

²⁶ (Rogoff 2014).

A system change that increases access for someone without worsening access for others in an absolute sense is a net improvement.²⁷ Paradoxically, however, this change may also worsen equity by some definitions, which considers the relative differences between groups. There are many different measures of equity, which makes even discussing equity in transport difficult.²⁸ Should we promote equality of opportunity (everybody has the same chance) or equality of outcome (everybody gets the same thing)?

²⁷ Referred to as a 'Pareto improvement' in the economics literature.

²⁸ (Palmateer and Levinson 2017; Martens et al. 2012).

Humans are social animals, and relative status is as important to many people as absolute wealth, at least above some minimum standard of living. We are on a hedonic treadmill.²⁹ While this drives progress as people innovate and compete to improve their own lot in life, relative status should not drive public policy. Someone always must be first and someone else is always last, and while people may be more absolutely equal, there is also always a difference in rank. So long as the least well-off gain access in absolute terms, we argue that we should think of it as an improvement.

²⁹ The phrase 'hedonic treadmill' refers to the idea that people have a relatively stable level of happiness, and events can't effect this much. You need to keep walking just to stay in place, but even if you run, you don't get any farther.

1.4 Why A Political Economy of Access?

Policy making takes place in a political and administrative system that is fragmented to the point of chaos. – Douglas Yates³⁰

³⁰ (Yates 1977) p.34.

Developing a city of high accessibility is a massive coordination problem. So, at the simplest level, access is improved through coordinated transport and land use actions. In an unregulated, competitive, free market, prices act to perform that coordination

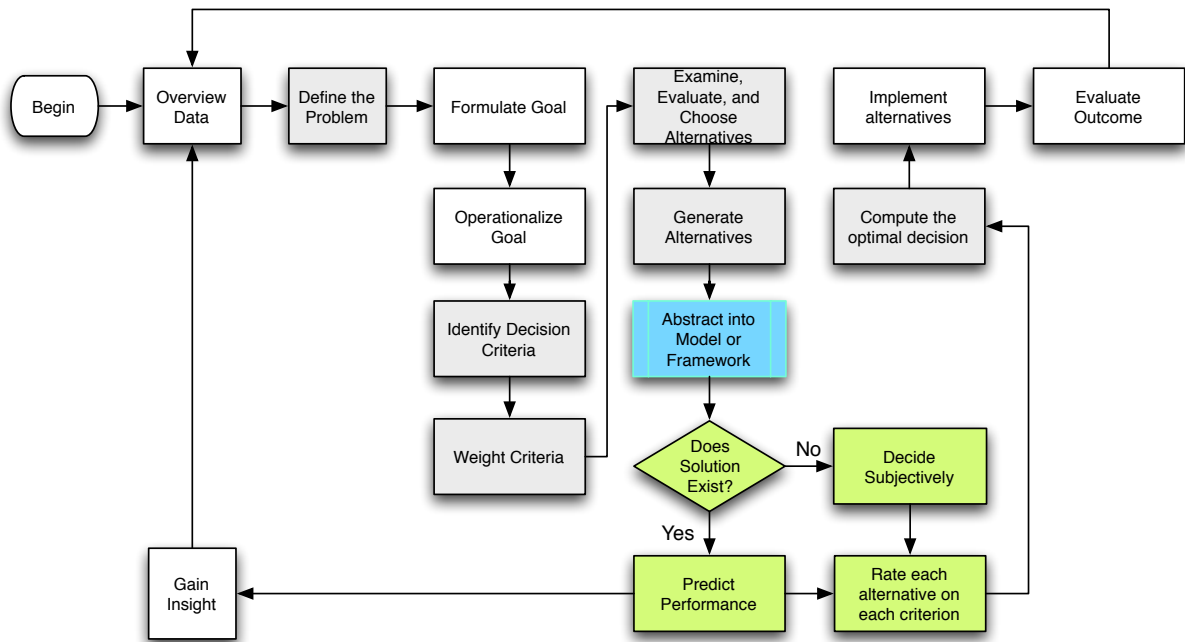


Figure 1.5: Rational planning and decision making model. This is not how decisions are actually made.

function. Cities are far from perfect free markets, as they have significant aspects of spatial monopoly and are highly regulated to control externalities. To the extent policies affect actions in the intended way, this means access improves where access promoting policies are adopted and access diminishing policies are not. But it is not so easy.

A common framework used to analyze planning is through the differences between the public sector and private markets. As a binary choice this distorts the mixed nature of urban systems. Transport and land use co-develop (or mutually decline) through the actions of public and private actors. At a basic level of analysis, public sector responses are due to some type of market failure (or market responses are due to government failure, depending on your perspective). In transport and land use, market failure often takes the form of negative externalities (congestion, emissions, noise, crashes, etc.) or inefficient supply of infrastructure.

There is no shortage of research that explores the relationships between transport and land use. These studies are nearly all about effects or outcomes, such as the effect of residential or employment density on transit ridership, does bike infrastructure increase the amount of cycling, does transit make us healthy (or short)?³¹ Collectively, these studies are what happens if a certain set of

³¹ (Ermagun and Levinson 2017).

interventions are made in certain types of places. We know far less about how to make things happen. The ‘how’ question is one of politics rather than transport expertise or need.

We see many scholars (and others) look at problems and propose intuitive sounding solutions, especially in the context of seemingly uncoordinated governance and institutions. For instance, a proffered solution to fragmented, city-by-city land use policy is state level planning – the assumption being that the outcomes under unified governance will be necessarily better than the status quo. This sounds reasonable, so to curb urban sprawl in the 1990s over a dozen states implemented statewide growth management regulations. The idea – following the theory stated above – was that local land use regulations lacked coordination to minimize environmental harms and other effects of sprawl, so state mandates would supersede and improve local decisions. These state efforts were successful politically in that they were adopted, but they had no effect on reducing the rate of suburban sprawl.³² So the politics worked but the policy didn’t – a familiar refrain.

³² (Anthony 2004).

Today we regulate land use in a way that was unknown in Adam Smith’s time. Smith was writing before the railroad and the industrial revolution, before zoning, the elevator, the high rise, the internal combustion engine, the automobile, the modern road, or even the United States. Of course, we also intensively use land far more than was common in all but the worst slums of 1776 (the largest city in the 13 colonies at the time of US independence was Philadelphia with 40,000 people). Our networks are far more comprehensive and faster than Smith could imagine, though in the US they have seen few improvements in speed for decades.

To understand how things are done, we need to look at how decisions are made. From a cursory glance at the state of the world, it is obvious that classical expectations of rational decision making, as shown in Figure 1.5, are not a reliable description of policy making. We can see the political economy of access in action through coalition building for investment. Within any region, developing a coalition in support of road projects is relatively straightforward. Roads are popular because roads are ubiquitous. Transit coalitions, by contrast, are much more difficult to assemble. Transit investment requires regional (or higher) coalitions to support the extremely high costs of construction, but since rail transit costs so much to provide, the total mileage built is small. Even with the dramatic increase in light rail transit (LRT) systems over the past three decades, there are still only about 1,500 km of total light rail track in the US, compared with approximately 9,000

km of track in Europe. In contrast, the City of Melbourne alone has 250 km of tram track, (which is a mix of what the US would call light rail and streetcar) but that serves under 5% of work trips per day in the region,³³ even relatively extensive transit networks are not as influential as they seem. To appeal to voters regionally, transit coalitions have to be built around benefits to drivers more than benefits to riders.³⁴ Thus, regional coalitions promote mobility improvements (faster travel speeds) rather than accessibility improvements.

US streetcar systems,³⁵ which generally promote economic development and property values over mobility or accessibility, are another interesting coalition. Streetcar coalitions bring together transit advocates – some of whom will support any transit investment – real estate interests and local economic development proponents. These projects are, in nearly all cases, transport projects that are developed apart from the existing transit agencies. Portland, Cincinnati, Atlanta, Kansas City, and others developed streetcar systems managed by non-profit corporations. Though the regional transit agency may be contracted to operate the system in some cases, streetcar systems are designed with separate sources of revenue to support development and operations to achieve economic development goals rather than access.³⁶

When the primary goal is to generate political support rather than improve accessibility, then any policy will do. This is roughly the way things are – the US has politically stable transport and land use policies. The problem is that these stable policies get our cities wrong, and many of us would like to see changes that improve cities for the better. If our goal is to improve access, and it is, the political coalitions needed to move forward politically are different than those that favor the *status quo*.

So have we learned anything since Adam Smith? In short, we have learned a lot, but we too often *relearn*³⁷ basic lessons rather than gain new knowledge.

In post-nomadic societies, transport in the absence of development, and development in the absence of mobility are equally pointless. Transport connects people with their destinations. These things are all well known, yet we continue to struggle with actually building cities with these principles in mind. This gap between the normative (what we know we should do) and the positive (what we actually do) comprises our the deficit of knowledge about the *Political Economy of Access*. So when trying to understand the political economy of access, we need to combine these historically *siloed*³⁸ fields.

³³ Overall transit share in Melbourne is higher, as it includes trains and bus.

³⁴ (Manville and Cummins 2015).

³⁵ §11.

³⁶ (King and Fischer 2016).

³⁷ §14.3.

³⁸ *Stovepiped*, for our industrial, rather than agrarian, readers; *sandboxed* for our information age friends.

Part I

Infrastructure Preservation

The problems of the surface transport system are well known. In this part we discuss the challenges of preserving, maintaining, and operating the existing system. In an economic sense, this can be considered the short-run problem, as we are keeping the network fixed.

Hierarchy of Needs

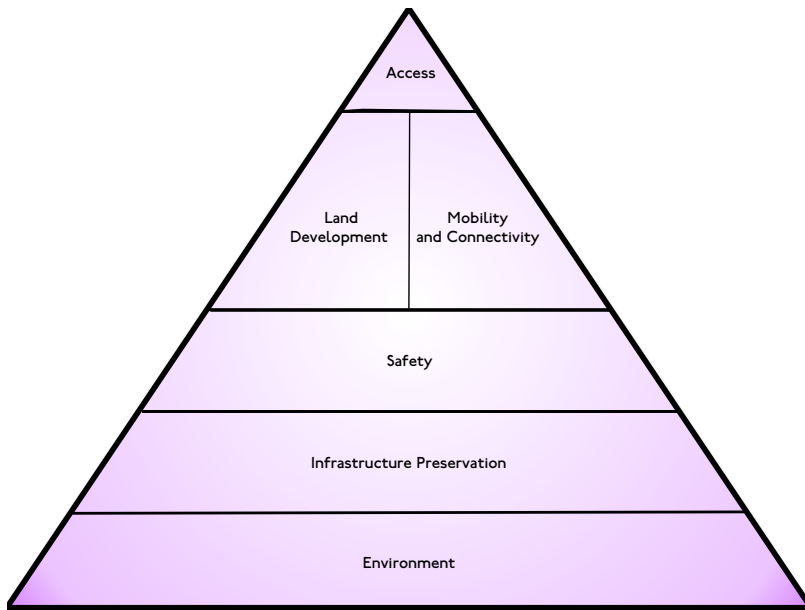


Figure 2.1: Hierarchy of Infrastructure Needs.

Borrowing from psychologist Abraham Maslow who formulated the Hierarchy of Needs for humans,¹ the 'Hierarchy of Infrastructure Needs' (Figure 2.1) offers a useful organizational framework for considering the priorities of transport investment to promote accessibility. In this part of the book, we focus on the idea of *Preservation*. In the next part we outline a 'Hierarchy of Infrastructure Wants' associated with *Network Expansion*.²

¹ (Maslow 1943).

² §II.

ENVIRONMENT. At the base of the hierarchy we place environment. Without breathable air, edible food, drinkable water, or a habitable climate, nothing else matters. This includes the challenge of climate change. The air pollution you breathe is the consequences of failure

³ §7.

to solve a collective-action problem. The pollution emitted by a tailpipe or smokestack is an economic [externality](#)³ not largely borne by those responsible, and not aimed at you. It is pumped into the air, mixed with everyone else's pollution, diluted with clean air, and makes everyone worse off. The Global Burden of Disease study estimates 36 deaths per 100,000 persons per year in the United States are due to air pollution, associated with increased rates of heart attacks and other diseases. Projects that can reduce these social costs will generally be underfunded by the private sector or public agencies without some specific support. Property markets do not work well for air pollution, and courts are a terribly inefficient mechanism to try to sort out pollution damages. This leaves us with inefficient though not ineffective regulations to deal with pollution. The key point is that the full cost of travel by automobile exceeds the private cost borne by individual travelers by a significant amount. While environment has always been an existential need, at the outset of the automobile era it was considered something beyond the influence of humans. The US government and public has since learned otherwise, and in addition to what has long been known about air pollution and health effects, recognizes that there is a risk of assuming the climate is independent of society.⁴ Some solutions are discussed in the chapter on [Pollution](#).⁵

⁴ (Reidmiller et al. 2018).⁵ §8.

INFRASTRUCTURE PRESERVATION. Without infrastructure (and the vehicles that avail themselves of it), we must resort to walking across the unimproved earth or swimming the waterways. If it is not preserved, at a fundamental level, infrastructure ceases to be. America's transport infrastructure is getting older faster than we are rebuilding it, and so is deteriorating. Solutions are discussed in the chapters on [Road Revenues](#)⁶ and [Subsidy](#).⁷

⁶ §3.⁷ §4.

SAFETY. At the next level of the hierarchy are safety and security. If people do not feel safe, they will avoid travel by that mode. We see this in urban transit, aviation, and in adverse weather. Over 30,000 Americans die in road [crashes](#)⁸ annually, and more than a million people globally.⁹ No new product with that kind of safety problem would be permitted on the market in any modern country. Though a vast improvement over previous years, it remains far too many, and one of the highest unaddressed costs of transport. People overestimate their safety by car (and underestimate their safety by other modes), perhaps because they feel in control. Most safety progress will occur due to vehicle improvements and changes in driver behavior (and ideally taking the driver out of the loop with

⁸ §7.7.⁹ (World Health Organization 2015).

vehicle automation), but safety can be enhanced through select infrastructure improvement projects. Safety is intertwined with justice. The expression ‘driving while black’,¹⁰ while not officially a crime on the books, has nevertheless remained a *de facto* offense in many parts of the United States, and has come to signify the racial discrimination faced by some members of society while driving (or walking or biking), with an increased likelihood of being pulled over, cited, arrested, or killed by police whose nominal task is to provide safety.

¹⁰ §22.

MOBILITY AND CONNECTIVITY. Despite, and in part because of, the Interstate Highway System, great cities often experience great congestion.¹¹ The traffic congestion you face is caused by other people. Those people did not think about the delay they imposed on you when they chose to travel. They didn’t even know about you, since they were already on the road before you were. They are ahead of you in the traffic stream. Similarly as a driver, you, obviously, impose congestion on those who follow. This is also a classic collective-action problem. Cars consume enormous amounts of *space* when they are in motion, but also when they are parked. We know how to address these problems. Specific solutions are discussed in the chapters on [Congestion](#)¹² and [Pricing](#).¹³

¹¹ The book *Great Cities and Their Traffic* came out in 1978 ([Thomson 1978](#)).

¹² §5.

¹³ §6.

LAND AND ECONOMIC DEVELOPMENT. Moving people faster and more directly, in order to expand accessibility, is the primary mission of state-level transport agencies. In most of the English Common Law countries, organizing land use is the remit of local planning and economic development agencies. In contrast, in places like Japan and Hong Kong, decisions are jointly made. Transport, while necessary, is insufficient on its own to induce developers to create places. Land and economic development at a site, which includes building at higher densities and the spatial reallocation of activities, requires the transport network to connect with other economic activities. Promoters often cite economic development as a reason for transport investment by the public sector. We suggest that if promoters believe in their project, they, not the government, should be liable for the risk that project fails to perform as expected, just as they would reap the benefits if it were to succeed. This topic is complex enough to warrant a part of its own: [Cities](#).¹⁴

¹⁴ §III.

ACCESSIBILITY. At the top we locate [Accessibility](#),¹⁵ discussed at the outset of the book, the ability to reach valued destinations. This is the primary purpose of transport: why travel but to get somewhere? It is

¹⁵ §1.

the product of the two factors immediately below it on the Pyramid: Mobility and Connectivity along with Land Development, and thus depends on infrastructure, people's feelings of safety and security using it, and an environment in which to operate.

2.1 *The nature of need*

Lots of numbers are thrown around about 'need' for road funding.

¹⁶ (Cambridge Systematics 2006) (Table A1).

¹⁷ (National Surface Transportation Policy and Revenue Study Commission 2008).

¹⁸ ASCE is the American Society of Civil Engineers, a professional association.

¹⁹ (ASCE 2013).

The National Cooperative Highway Research Program¹⁶ finds an annual need of \$188.4 billion in 2007 dollars to maintain existing highway infrastructure, of which \$109.8 billion is capital and the remainder (\$78.6 billion) is operations and maintenance costs. The National Surface Transportation Policy and Revenue Study Commission also has estimates which are higher,¹⁷ and the ASCE Report Card says about surface transport (roads, bridges, and transit) "We are facing a funding gap of about \$94 billion a year with our current spending levels."^{18,19} These numbers are of course different, but all very similar, especially given the large span of years over which they have been reported. There is a reason they are similar; they derive from the same source.

The root source of most of these 'need' numbers are various runs of the Federal Highway Administrations Highway Economic Requirements System (HERS, and later HERS-ST),²⁰ HERS is probably the best available system for systematically building up an 'engineering' estimate of needs, based on the condition of individual links in their database. While it is the best available, HERS is far from perfect. As the description says

²⁰ See (TRB Transportation Economics Committee 2018) which has been evaluated by GAO (US General Accounting Office 2001a;b).

The program is noteworthy for its ability to conveniently perform sensitivity analyses in order to test whether the solution of recommended investments is robust to changing system goals and underlying parameters. Note that HERS does not reallocate traffic to reflect highway improvements. However, traffic growth induced by improved capacity and operating conditions is included, with half the estimated user benefits counted for *induced traffic*²¹ consistent with consumer surplus principles. (FHWA, 2002d).

²¹ §14.

As with anything, the output depends on the inputs. If traffic is expected to grow, the need for additional capacity resulting from this kind of comparative statics analysis will be higher than if traffic is expected to be flat. The forecasts are exogenous, this is not a transport planning model. And while 'induced demand' is sort of included, unless it is analyzing network flows, it can't really be. If a link upstream of the link in question is improved, it will induce additional traffic both upstream and downstream (and reduce traffic

on competing links). This induced traffic is due to rerouting, switching time-of-day or day-of-week, switching modes, making longer trips, and making trips that would not otherwise have been made, among other sources, and over the long term by encouraging new development. A network analysis is required.

HERS is far better for assessing pavement quality issues (for which links are separable) than level of service issues (for which they are not). To be fair, the more recent analysis conducted for ASCE tries to address this question in part by looking at a national Freight Analysis Framework (FAF) network, and assigning (and reassigning) traffic to account for rerouting. But the FAF uses a really crude sketch network, and the equilibration assumptions are not clearly laid out, and how the level of demand itself responds to travel times is not accounted for.²²

So using the HERS estimates for preservation is sounder than using the estimate for ensuring the same Level of Service (LOS). These two numbers are often combined and conflated. They should not be.

There is also undoubtedly some arbitrariness in pavement performance standards, bridge conditions, and other infrastructures as well, though we doubt it rises to the level of arbitrariness of highway LOS.²³

There are 'needs' to make sure the highway system does not eventually crumble into dust, and there are 'needs' to ensure it maintains the same level of service. As we may have learned from *Sesame Street*, one of these 'needs' is not like the other. Estimates of need are likely overstated, both for reasons of methodology and due to motivated reasoning.

2.2 The state of infrastructure

Let's ask two questions:

- Is existing infrastructure in good shape? [Yes or No]
- Should existing infrastructure be in good shape? [Yes or No]

The answers to these questions might indicate an answer to the question of whether infrastructure requires more funding.

The first question is empirical, and so depends on what standard you apply to 'good shape.' There are empirical ways to assess road quality, one is the roughness index (assessed by running a vehicle with a trailing wheel, the cumulative vertical movement of the trailing wheel per unit distance is a measure of roughness). Clearly

²² (American Society of Civil Engineers and Economic Development Research Group 2011) p.34.

²³ California recently abandoned LOS for project evaluation. (Newton and Curry 2014).



Figure 2.2: Weak Bridge: Hammersmith Bridge, London. Source: Jeremy Keith. Used under Creative Commons License

Figure 2.3: Normative and Positive Infrastructure.

		Infrastructure should be in:	
		Good Shape	Bad Shape
Infrastructure is in:	Good Shape	(1) Do nothing	(2) Cut funding
	Bad Shape	(3) Raise funding	(4) Do nothing

some roads are smoother than others. New roads tend to be smoother than older roads. Roads before snow plowing are smoother than roads after snow plowing.

You may believe infrastructure is in good shape, or you may not. Hopefully everyone agrees on the physical measurements, such as road roughness. However, the assessment of whether a given level of roughness is ‘good’ or ‘poor’ is subjective. Nevertheless, the more worn out the road (the rougher it is, the more ruts it has, and so on), the more expensive it is to restore, and the more likely people will assess it as ‘poor’ rather than ‘good.’

The second question is normative: should infrastructure be in good shape (relative to its existing state)? Some advocates for non-auto modes of transport have argued that the worse roads are, the more people will switch modes. Neighborhood activists also argue against smooth roads as a way of discouraging traffic (a natural form of traffic calming).²⁴ Underfunding of buses has been used to support rail transit.

Suppose there were signs on each bridge saying whether or not it was ‘structurally deficient,’ similar to Figure 2.2. Would this encourage people to take investment seriously?

Or would people reroute around structurally deficient bridges and get into more crashes, with a net increase in fatalities, given that the likelihood of dying on a bridge collapse is quite small compared to other causes of death.

So combining the answers to these two questions we have Figure 2.3, with the natural policy prescription regarding funding in the appropriate cell, assuming money is required to maintain or rebuild infrastructure.

Given that the number of people who actually believe infrastructure should be in bad shape is small, the main debate is between (1) and (3). Given not many people would say infrastructure is in good shape in most urban areas, raising funds for infrastructure, should be as they say, a no-brainer.

²⁴ The Old Cedar Avenue Bridge in Bloomington, Minnesota was not maintained for years, and the neighbors loved it because they used it for walking and cycling and such. Then the state wanted to fix the bridge and improve the road, which the neighbors initially opposed. (Castleman 2016; Otárola 2016).

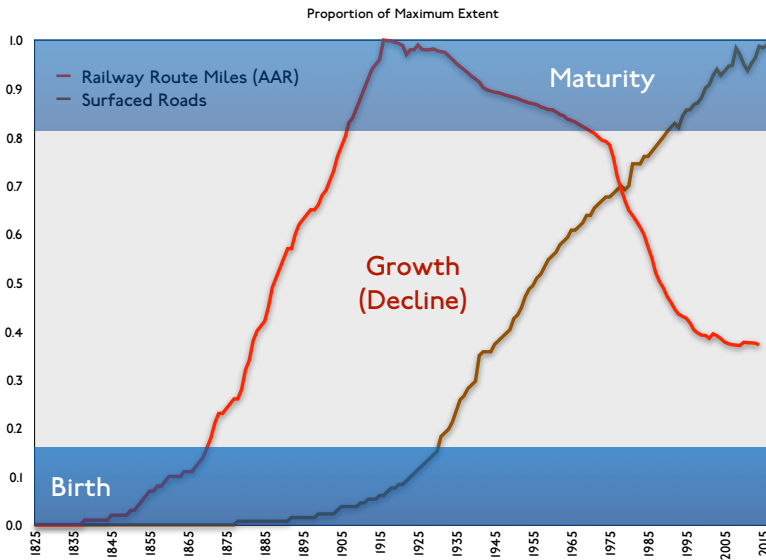


Figure 2.4: The lifecycle of birth, growth, maturity and decline of infrastructure. Source: American Association of Railways, Bureau of Transportation Statistics, Author Calculations.

2.3 Infrastructure triage

The United States has been falling behind on infrastructure maintenance for decades. If this continues, a form of infrastructure *triage* may be required, shuttering the least important (or most expensive) facilities to devote resources to those that can be retained. The country is just beginning a serious conversation about systematic, and ideally graceful, highway infrastructure triage,²⁵ but there are elements of this already occurring: In recent years counties in at least 27 states have converted once paved low volume rural roads to less expensive to maintain (but slower to drive on) gravel as they can no longer afford to maintain the pavement,²⁶ reducing the number of bridges, or plowing less in the winter, all of which increase travel time and thus reduce accessibility.²⁷

Some cities have closed and deconstructed freeways (including New York's West Side Highway, San Francisco's Embarcadero and Central Freeways, Milwaukee's Park East Freeway, and Portland's Harbor Drive freeway) both because of physical obsolescence and a desire to improve the urban environment. The first three examples also had catastrophic failure and the cost of rebuilding versus conversion to boulevard-type facilities was seen as too great, in part because traffic wasn't as bad after collapse as feared. Due to the effects of climate change, we should expect more facilities to fail, especially in coastal areas prone to flooding. North Carolina, for instance, is debating the future of their Outer Banks, which are

²⁵ (Kurutz 2017).

²⁶ (Louwagie 2011; Etter 2010; Martin 2009; Batheja 2013; Overstreet 2010; Kalamazoo Gazette staff 2010; Marshall 2016).

²⁷ (Nyamaah and Hitzhusen 1985; Hamlett and Baumel 1990).

barrier islands in the Atlantic Ocean. During Hurricane Irene in 2011, NC 12, the only road serving the popular tourist area, washed out in multiple places. It was replaced with ferries until a replacement was built, but concerns remain that the new bridge is vulnerable to future floods, and the islands themselves are shifting and washing away.

²⁸ 250,000 route *mi*.

Moreover, the historical record is clear from older modes, as seen in Figure 2.4, railroads peaked at just over 400,000 route *km*²⁸ in the 1910s, and declined to less than half that by 2000 (while ton-miles of freight continued to increase). Similarly rail transit, canals, and turnpikes all saw rise and falls. Even with select abandonment, revenue is required to keep local streets and roads operating for decades to come. Proper management of roads with scarce resources may require some abandonment and reversion, but it also requires revenue to maintain and expand critical links.

2.4 Report cards

²⁹ (ASCE 2017).

The American Society of Civil Engineers (ASCE) is a professional society that represents many civil engineers. They produce an annual report card that says the US needs more infrastructure spending, and so should hire more civil engineers. This is entirely predictable even without knowing the state of US infrastructure, they could hardly call for the opposite. In fact, the ASCE's report card²⁹ gives both roads and water a 'D' letter grade. ASCE calls for \$170 billion in annual road spending split between repair and operation of existing roads and expanding highways. Are roads and water both as bad as a 'D' grade? They write:

At the dawn of the 21st century, much of our drinking water infrastructure is nearing the end of its useful life. There are an estimated 240,000 water main breaks per year in the United States. Assuming every pipe would need to be replaced, the cost over the coming decades could reach more than \$1 trillion, according to the American Water Works Association (AWWA). The quality of drinking water in the United States remains almost universally high, however. Even though pipes and mains are frequently more than 100 years old and in need of replacement, outbreaks of disease attributable to drinking water are rare.

³⁰ In 2016 a federal emergency was declared for the city of Flint, Michigan after it was discovered that the drinking water was contaminated with lead due to poor treatment and old pipes. Treatment was improved and pipes were replaced, and the city's water was below acceptable thresholds by the end of 2017. The contamination could and should have been avoided.

To be sure 240,000 sounds like a big number, but it is less than 1 break per 1000 people in the US. (Of course water mains serve more than 1 person, but that count of failures includes many, many small ones for each one that gets on the news). Certainly drinking water in the US could be better somehow, and Flint is a tragedy,³⁰

but almost everyone in the US turns on the tap and gets clean water instantly. The water is safe, and so almost no one in the US dies from contaminated drinking water anymore. A 90+/100 usually scores an A. The environmental engineers are to be commended. They have been so good, they almost put themselves out of a job.

So let's grant that over the next 100 years all the pipes need to be replaced due to potential failures (broken mains, leakages, etc.). And let's grant that would be \$1 trillion (ignoring inflation/discounting etc). This seems a lot, like about \$3000/person. But that's still only \$10 billion/year (or \$30/person/year) which is \$2.50 per person per monthly water bill for capital replacement, or \$0.10/day/person, which seems eminently doable, and is the responsibility of local water utilities.

If you think it needs to be done in 50 years, double it. This hardly constitutes a crisis. In medical terms, the condition is chronic, not acute.

About roads, ASCE writes:

Forty-two percent of America's major urban highways remain congested, costing the economy an estimated \$101 billion in wasted time and fuel annually. While the conditions have improved in the near term, and Federal, state, and local capital investments for road infrastructure increased to \$91 billion annually, that level of investment is insufficient and still projected to result in a decline in conditions and performance in the long term. Currently, the Federal Highway Administration estimates that \$170 billion in capital investment would be needed on an annual basis to significantly improve conditions and performance. We have several caveats"

- The phrase "conditions *and* performance" means maintaining highway LOS, not just pavement surface quality.
- This is for unpriced roads. If roads were properly priced, congestion would go down significantly. Pricing³¹ also raises revenues. ³¹ §6.
- It makes no assumption about more efficient use of roads from autonomous vehicles, let alone what vehicles might look like in the future. While they are not deployed yet, over the expected lifetime of new infrastructure, they will be. It takes a particular type of ostrich to just ignore this.
- Again they don't make the case as to why this (or any of it) is a federal rather than state and local responsibility. They do say "federal, state, and local" need to come up with the money, and they are indifferent to which (green is green).³² But it matters in practice. ³² US currency is historically green.

Table 2.1: International Roughness Index and Bridge Sufficiency Index.

	International Roughness Index (per lane-km)	Bridge Sufficiency Index
Very Good	<0.95	80-100%
Good	0.95-1.5	60-80%
Fair	1.5-2.7	40-60%
Poor	2.7-3.5	20-40%
Very Poor	>3.5	<20%

³³ (Schrunk et al. 2012).

- It appears \$101 billion in annual wasted time and fuel is supposed to be solved by \$170 billion in annual investment.
- While \$101 billion sounds like a lot of time and money, this is of course a Texas Transportation Institute (TTI) Urban Mobility Report estimate.³³ It is a little over \$300/person/year, or less than \$1/day/person, or less than \$0.25/trip, which is again annoying and perhaps needlessly wasteful, but hardly a crisis.

So yes, Roads get scored a ‘D,’ and this is probably more apt than water, and we could do better, but we do not think the solutions are what ASCE seems to think they are.

So what does a ‘D’ even mean?

“POOR: AT RISK The infrastructure is in poor to fair condition and mostly below standard, with many elements approaching the end of their service life. A large portion of the system exhibits significant deterioration. Condition and capacity are of significant concern with strong risk of failure.”³⁴

³⁴ The rubric is given at (ASCE 2017).

If we provided our students with a grading rubric that vague they would rightly complain. ‘Good’ and ‘fair’ (and so on) conditions are labels for specific performance levels in each infrastructure (roads, bridges, others). They tend to be defined according to specific reasonably objective performance levels for a specific technology (for example pavement roughness for pavement, bridge conditions for bridges). We have questions:

- How is a ‘good’ road compared to a ‘good’ bridge?
- When ASCE says ‘many,’ how many?
- When they say ‘a large portion,’ what share?
- When they say ‘strong risk of failure,’ how strong?

If a bridge were known to have even a one in a thousand chance of failing tomorrow, it would be closed immediately by the Professional Engineer in charge. A bridge failure is very different

than a road failure (and pavement condition failure is different from level of service failure).³⁵

Not all roads are in poor to fair condition. Many are brand new. Many elements are, in fact, nearing end of life, but of course, many should be, that is what is meant about managing across the lifecycle. It would be terribly inefficient if everything opened in the same year and then failed exactly 50 years in the future. When we know where a facility is on the life-cycle, at some appropriate point we make a repair/replace/abandon decision.

It is straight-forward to grade individual elements in a given technology: An 'A' vs a 'D' bridge is perhaps a meaningful comparison if it represents the same objective elements.³⁶ How are bridges averaged across the system?³⁷ One could certainly have an average bridge or average road, but those are always fine, usually people talk about the share of bridges which are 'structurally deficient' (or 'functionally obsolete') or in 'poor condition.'³⁸

2.5 *Infrastructure heal thyself*

So what is the problem?

Perhaps people believe infrastructure will heal itself. We should investigate technologies that can do the latter (self-annealing roads would be great), and there is in fact some good research in this direction.³⁹ But we are not there yet.

Alternatively, perhaps people do not believe the money will be well-spent – so the more fundamental problem is the lack of confidence about spending.⁴⁰

This distrust is general, but especially emerges when decisions are politicized. 'Bridges to Nowhere,'⁴¹ while a small-part of actual transport funding, garner much of the attention. Pothole fillers not doing their job get media, those actually filling potholes do not.⁴² Because these are public sector investments, they garner much more attention than private sector utilities. Some telephone company employees have loafed at some point in their careers, without making the news.⁴³

This leads to the conclusion that the problem with raising funds is the public and political nature of transport funding. To analyze the politics, we can break transport investment into 'needs' and 'wants', and how the two are conflated, which we address in [part IV](#)⁴⁴ of the book.

³⁵ Bridge closure actually happens fairly frequently. One example is the Vilas Bridge between Vermont and New Hampshire. The bridge was closed without warning in 2009 despite daily traffic of about 5000 cars. It has not been replaced, nor has it fallen. Vermont continues to press for rehabilitation, but New Hampshire owns 93% of the bridge and is not terribly interested in paying to repair a bridge that primarily benefits Vermonters.

³⁶ Also note that scoring a report card grade of 'A' (and maybe 'B' or 'C') is overbuilding for anything but a brand-new infrastructure.

³⁷ We all know how to do an average, but there are many ways to do averages, and they usually should be weighted somehow.

³⁸ For bridges, see ([Associated Press 2013](#)) or this similar bridge tool by T4 America ([Transportation for America 2015](#)).

³⁹ ([Gallego et al. 2013](#); [Qiu et al. 2009](#); [Qian et al. 2009](#); [García 2012](#); [Xu et al. 2018](#)).

⁴⁰ This is the credible commitment problem, which explains some of the public opposition to road pricing ([Manville and King 2013](#)).

⁴¹ The expression 'Bridge to Nowhere' gained currency in American politics as it was used to criticize the Gravina Island Bridge in Alaska. To its belated credit, Congress ultimately cancelled the project. ([Associated Press 2007](#)).

⁴² Unless they are politicians creating potholes to fill them. ([Marinucci 2005](#)).

⁴³ In fact some telephone company employees have listened in on private phone calls for fun, while purportedly for service quality.

⁴⁴ §IV.

3

Road Revenues



Figure 3.1: Hibbs Bridge on Snicker's Gap Turnpike. Source: Wikimedia Commons.

It is easy to claim that streets and highways are deficient and need more money. It is much harder to agree on what a financially sustainable model should look like. The history of funding roads is one of trade-offs between user fees, general taxation and efforts of privatization. The original user fees were road and bridge tolls.

3.1 From Snicker's Gap to funding gap

The first toll road in the US, the Snicker's Gap Turnpike opened in 1786, connecting Alexandria, Virginia with its hinterlands. This launched an era of toll-road building, mostly for intercity routes, in the United States which lasted through the second half of the 19th century.¹ Toll-roads were never very profitable, but often broke even, and were sponsored in many cases by local elites as an

¹ (Klein and Fielding 1992).

economic development mechanism rather than with the intent of making riches. Local landowners would capture some of the benefits of the accessibility these new routes created, and in turn, helped fund them.

Still, most roads, and most streets, were untolled, and not very improved. With the advent of the canal and then the railroad² providing much better service than land transport could, long-distance turnpikes began a decline, though turnpikes feeding into railroads remained in many places through the 19th century.³

The turn of the 20th century saw the emergence of the automobile which, coupled with the Good Roads Movement,⁴ redefined surface transport. Roads would naturally be more expensive if they had to be smooth, strong, and straight for cars, buses, and trucks. Local roads continued to be funded mainly out of general revenue (which is the property tax in most places). More important roads would be supported by state governments.

Since 1919, when Oregon first adopted the gas tax⁵ as a means of funding roads, the ‘user pays principle’ has been an important foundation of debates about transport funding. Yet we in the US have never had anything like 100% user funding, local roads have generally not been user-funded, particularly since the 20th century and the decline of turnpikes. Purely local streets are generally paid for through property taxes. Dedicated funding for state and federal sources are mostly from gas taxes now, but the share of total spending from gas taxes has been dropping.

In 1956, the Federal gas tax was raised from \$0.01 to \$0.03 to fund the Interstate Highway System and establish its pay-as-you-go funding mechanism, the Highway Trust Fund (HTF). The money in the HTF was dedicated to roads.⁶ Later a Mass Transit Account was added which diverted road user funds to pay for transit projects.

Federal gas taxes were raised periodically in the Interstate era, though, as of this writing, have not been raised at the federal level since 1993, as shown in Figure 3.2.⁷ This despite a growing US population, growing US GDP, and rising costs of maintenance. Between 2013 and 2017, 26 states raised their gas taxes.⁸

To be clear, reliance on general revenue to fund roads does not mean it is impossible for roads and highways to be financially self-sustainable. It is in fact very possible for many of them, and for roads collectively. Instead it is because politicians don’t want to raise taxes, and because everyone else – each constituent – (rationally) wants a free ride. However, at some point, as the state but not the federal governments realize, the political costs of terrible roads outweigh the political costs of raising taxes.

² The Erie Canal opened in 1825. The Baltimore and Ohio Railroad broke ground in 1829.

³ (Klein and Majewski 1992).

⁴ The Good Roads Movement originated by the booming bicyclist community in the late 19th century.

⁵ For simplicity we are using the common US terms ‘gas’ and ‘gasoline’ for ‘petroleum’ or the more general ‘fuel’. We also note that in the US gasoline and diesel are taxed at different rates.

⁶ The terms *hypothecated*, *ring-fenced*, and *earmarked* are often used synonymously to describe the HTF, and just mean the funds are dedicated.

⁷ With the wonkish aside that in 1998 some federal gas tax funds were reverted from deficit reduction back to the HTF.

⁸ (Quinton 2017).

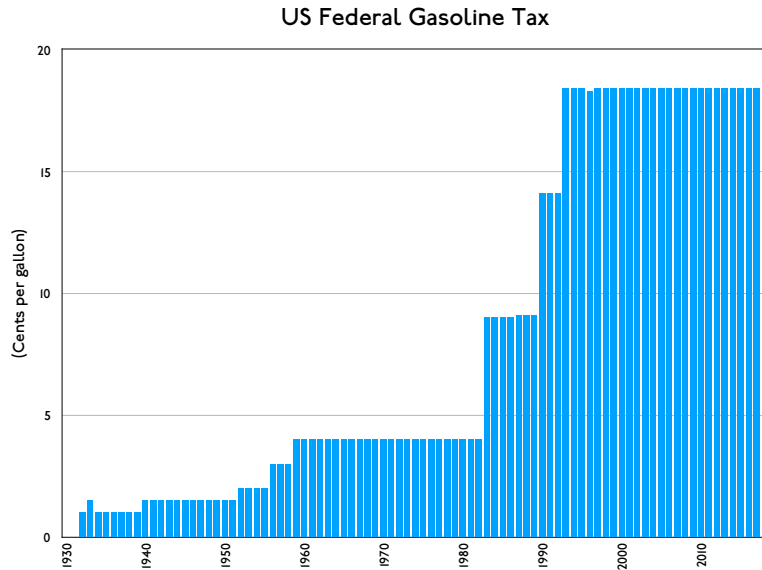


Figure 3.2: US Federal Gas Tax History.

US FEDERAL ROAD FUNDING IS BROKEN.⁹

1. Since the mid-2000s the Highway Trust Fund has seen spending in excess of revenue.¹⁰
2. We spend on new projects while giving short-shrift to maintenance and reconstruction.
3. We suffer [congestion](#),¹¹ which is avoidable with road pricing.
4. User fees fall far short of infrastructure and [social costs](#),¹² of transport.
5. We use pay-as-you-go financing to pay for projects that are supposed to last decades.
6. We invest in projects that have poor benefit/cost ratios (BCR), and prioritize badly.
7. We plan and invest as if transport technology and behavior will never change.
8. Roads, and especially federally funded roads, are not generally a [public good](#).¹³ They may be private, or club, or common-pool resource or public, depending on their architecture. The Interstate is both excludable and rivalrous, making it a classic 'private good' which happens to be publicly provided.
9. Investment decisions are made at the wrong level of government, too far from the the locus of day-to-day involvement in transport. The idea of [subsidiarity](#)¹⁴ is ignored.

⁹This responds to debates on the issue of how to fund transport. For some additional context see ([Drum 2015](#)) responding to ([Pethokoukis 2015](#)).

¹⁰([Urban Institute and Brookings Institution 2018](#)).

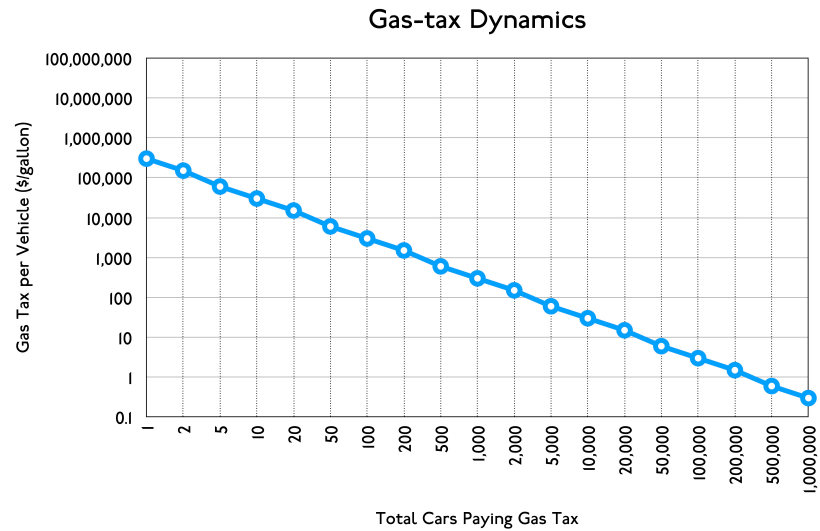
¹¹ §5.

¹² §7.

¹³ §A.

¹⁴ §17.1.

Figure 3.3: Gas Tax Dynamics.



3.2 *How the gas tax may fail*

While the state of the system is bad enough in the present, it is also vulnerable to future shocks.

Electrification

¹⁵ (Levinson and Krizek 2018).

As we argue elsewhere,¹⁵ the gas tax will eventually come to an end if only due to the transition towards vehicle electrification. Figure 3.3 illustrates the issue.

THINGS THAT ARE UNSUSTAINABLE DO NOT SUSTAIN. Imagine all gasoline vehicle users pay for all transport costs. Imagine total expenses are \$100,000,000 and the total number of users are 1,000,000, and all gasoline powered cars get 7.84 L/100km.¹⁶ In that case, when all vehicles are gasoline powered, the gas tax will be \$0.0792/L,¹⁷ in line with current levels. Now imagine, only half of all cars pay the gas tax, the tax doubles to \$0.1585/L¹⁸ to cover costs, still quite tolerable, but as the gas tax rises, the number of gasoline powered cars should be expected to fall. Figure 3.3 shows the expected gas tax based on the above assumptions with a varying number of gasoline powered cars on the road. Note especially this is a log-log scale. At 50,000 cars with gasoline engines (95% non-gasoline powered.), the tax jumps to \$1.58/L¹⁹ but the last gasoline-powered car has to pay \$79,200/L.²⁰ Obviously this is unsustainable.

¹⁶ 30 mpg.

¹⁷ \$0.30/gal.

¹⁸ \$0.60/gal.

¹⁹ \$6.00/gal, above European levels.

²⁰ \$300,000/gal.

The move away from the gas tax is a positive feedback system that will accelerate. A replacement is required. This is [road pricing](#)²¹ using location technology.²²

²¹ §6.

²² (Zhang et al. 2009; McMullen et al. 2010).

State opt-outs

Just as individuals effectively opt out of the gas tax when they drive electric vehicles, a bill was introduced by Senate Republicans that would have allowed states to opt out of the federal highway program.²³ While this is unlikely to actually happen, consider this thought experiment.

²³ (Utt 2011).

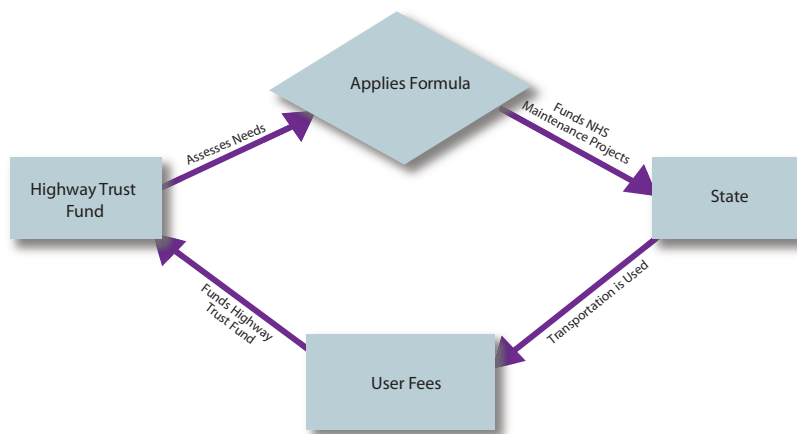
Imagine the Highway Trust Fund were the only source of federal revenue to states, and it were fully funded from fuel taxes. Let's assume half the states are donor states, and pay in more than they get back, and half are donee states, and get back more than they put in.²⁴

²⁴ The real world is more complex. The US Federal Gas Tax used to be the primary source of the Highway Trust Fund, so this was once true, but now most states are donee states because in recent years, Congress has topped up the Trust Fund with general revenue to enable more to be spent on highways than was collected in fuel taxes.

- Day 1: All (25) the donor states opt out. There are now 25 states in the gas tax pool. In this new pool, half the states are donor states, half are donee. The funds had to be recalibrated based on the smaller pool.
- Day 2: All (say 13) of the new donor states opt out. There are now (let's say 12) states left in the pool. Half the states are donor states, half are donee. The HTF allocation again had to be recalibrated based on the smaller pool.
- Day 3: All (6) the donor states opt out. There are now 6 states left in the pool. Rinse and repeat.
- Day 4: All (3) the donor states opt out. There are now 3 states left in the pool. One more time.
- Day 5: All (1) the donor states opt out. There are now 2 states left in the pool. One last time.
- Day 6: All (1) donor states opt out. There is only 1 state left in the pool. The federal government eliminates the gas tax program.

OPT-OUT OF CROSS-SUBSIDIES LEADS INEVITABLY TO
ELIMINATION OF CROSS-SUBSIDIES. TAXES CANNOT BE OPTIONAL.

Figure 3.4: Fix-it-First. Source: (Kahn and Levinson 2011).



3.3 Fix-it-first

Kahn and Levinson's *Fix It First, Expand It Second, Reward It Third: A New Strategy for America's Highways*²⁵ addressed setting priorities for the road sector in addition to what to do with expenditures. The Obama administration cited it,²⁶ so while it is perhaps novel, and definitely a good idea, this is hardly some radical notion; it is only innovative within the confines of federal policy discussions. This section summarizes that proposal for federal transportation priorities.

²⁵ (Kahn and Levinson 2011).

²⁶ (National Economic Council and the President's Council of Economic Advisers 2014).

FIX-IT-FIRST. At the national level, policymakers should dedicate existing federal highway user fees to preserve the National Highway System network. While some funds now go to that purpose, a large share of funds goes instead to highway expansion and new transit projects, neither of which rise to same level of national justification. To retain today's transport revenue sources, ensure the funds are directed to appropriate national aims.

It is more important to maintain the existing network than to expand it, since (a) transport planners have already done the work of finding the best routes on which to build roads, and (b) Americans have built lives and communities around the existing network. Projects that ensure existing links remain open thus have higher benefit/cost ratios than speculative new roads (often built only because proponents can spend other people's money rather than their own).

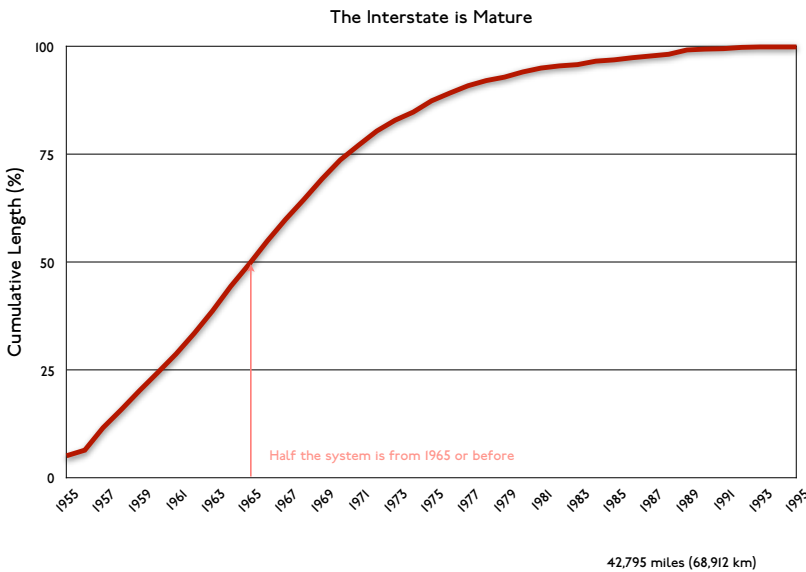


Figure 3.5: The lifecycle of the Interstate Highway System.

Highway Block Grants would be a way to pursue this approach while significantly reducing the active federal role in surface transport. Money raised in metropolitan areas would be returned to the area in which it was generated, to be allocated locally to preserve and maintain (but not expand) the National Highway System. Similarly, revenues collected outside of metro areas would be returned to states to distribute to projects outside metro areas. No other strings would be attached; states and metro areas would have autonomy within these limited guidelines to make their own spending decisions.

The priority of public (federal, state, and local) investment in transport should be on repair because most of the system is built out, and travel demand is largely flat, so there's not a major need for expansion nationally, despite calls from the Highway and Trucking lobbies. The median age of an Interstate highway link in the US is about 50 years old now, and the expected lifespan of such links was on the order of 50 years, as shown in Figure 3.5. While certainly some links have been rebuilt, many if not most bridges are the originals. Most of the infrastructure around 10 years from now is there now, and to ensure it is there ten years from now road agencies must reconstruct, restore, or repair and maintain it.

From a life-cycle perspective, the problems highways face aren't those of growth but of maturity, and maintenance is foremost, and discovering and developing new technologies to replace the old.

More significantly, the states should be addressing this. They can prioritise investments and repairs locally, they know where the issues are, and they're the beneficiaries. States know how much they need to spend locally to satisfy the local risk-reward, benefit-cost ratio. The federal government allocates things by formula and that means there's a major inefficiency there.

²⁷ (Global Construction Review 2013).

In the 2013 State of the Union Address, President Barack Obama announced a *Fix-it-First* plan as part of his transport agenda.²⁷ President Obama called for \$50B in new funds. No one really knows the amount of money that is enough, it depends on standards (what is good enough), how repairs are done, what timespan is being considered, and so on. What President Obama proposed, for instance was about the equivalent of one year's federal spending on roads. So it would be adding 10% more over 10 years. It's not trivial, but it's not going to solve the problem, either. We are happy the idea has legs, and even if the final plan was not the same as what we proposed, moving policy in the right direction is the whole point of policy briefs.

Both proposals identified the same problem, existing infrastructure is aging and without additional resources will deteriorate further.

There is room for debate as to who should fund this infrastructure, but given the Federal government believed constructing an Interstate Highway System was of national interest, and paying for a National Highway System is of national interest, and that there are existing funds which are largely returned to the states proportional to where the revenue is generated, keeping existing revenue sources in the short term is consistent with broader policies and is politically prudent (it is easier to maintain an existing tax than to fight 50 fights in 50 state legislatures about raising new taxes to pay for the same roads).

²⁸ §6.

As authors playing economists, we are required by the economist's guild to say 'We should also have [congestion charges](#).'²⁸

...

²⁹ §I.

*Fix-it-first focuses on the problem of [Infrastructure Preservation](#),²⁹ the topic of this part of the book. The next two items: *Expand-it-Second* and *Reward-it-Third* relate to [Network Expansion](#),³⁰ the subject of part II of the book, and are described here for coherence.*

³⁰ §II.

...

EXPAND-IT-SECOND. President Obama also proposed a National Infrastructure Bank, ours was a more limited Highway Bank where

borrowers would need to repay funds through from project beneficiaries (user charges or land value capture). Ours was a self-sustaining, independent Government Sponsored Enterprise. These are reasonably similar ideas, earlier ideas for an Infrastructure Bank have included grant-making powers, our view (and what appeared to be the Obama Administration's view) is that the Bank should lend money, and expect repayment, with interest, and should thus expect to be revenue positive over the long haul.

The Administration also proposed enacting America Fast Forward Bonds, and implementing the Transportation Infrastructure Finance and Innovation Act (TIFIA) program. Implementing TIFIA is of course current law, so that is not really a new initiative. TIFIA does many similar things to the proposed Highway Bank, but it is lodged within USDOT rather than independent. It is also not well funded.

The Brookings report did not have any particular viewpoint on bonds, except to the extent Kahn and Levinson envisioned the Highway Bank selling Bonds based on portfolio of projects (much like how mortgages were once bundled before financial deregulation) to raise funds, and imagine that similar tax benefits can be used. The market in the end will limit the availability of funds for self-liquidating projects. So rather than bond investors being paid from individual projects, they would be paid from a bundle of projects, lowering risk and interest payments. Many communities have difficulties participating in the municipal bond market, since, especially small communities, do this infrequently, while the professionals on Wall Street know many angles.³¹

REWARD-IT-THIRD. The Highway Bank would require benefit/cost analysis. Outperforming projects would get an interest rate subsidy from the Highway Performance Fund (basically funded by the profits of the Highway Bank) to reward *ex post* the lower actual risk. This would help encourage jurisdictions to under-sell their projects (under-estimating demand and over-estimating costs) so that they can outperform, rather than the current strategy of over-selling the projects (over-estimating demand and under-estimating costs) to get initial funding.

...

³¹ Brookings' Hamilton Project has another proposal on Municipal Bonds. (Ang and Green 2011).

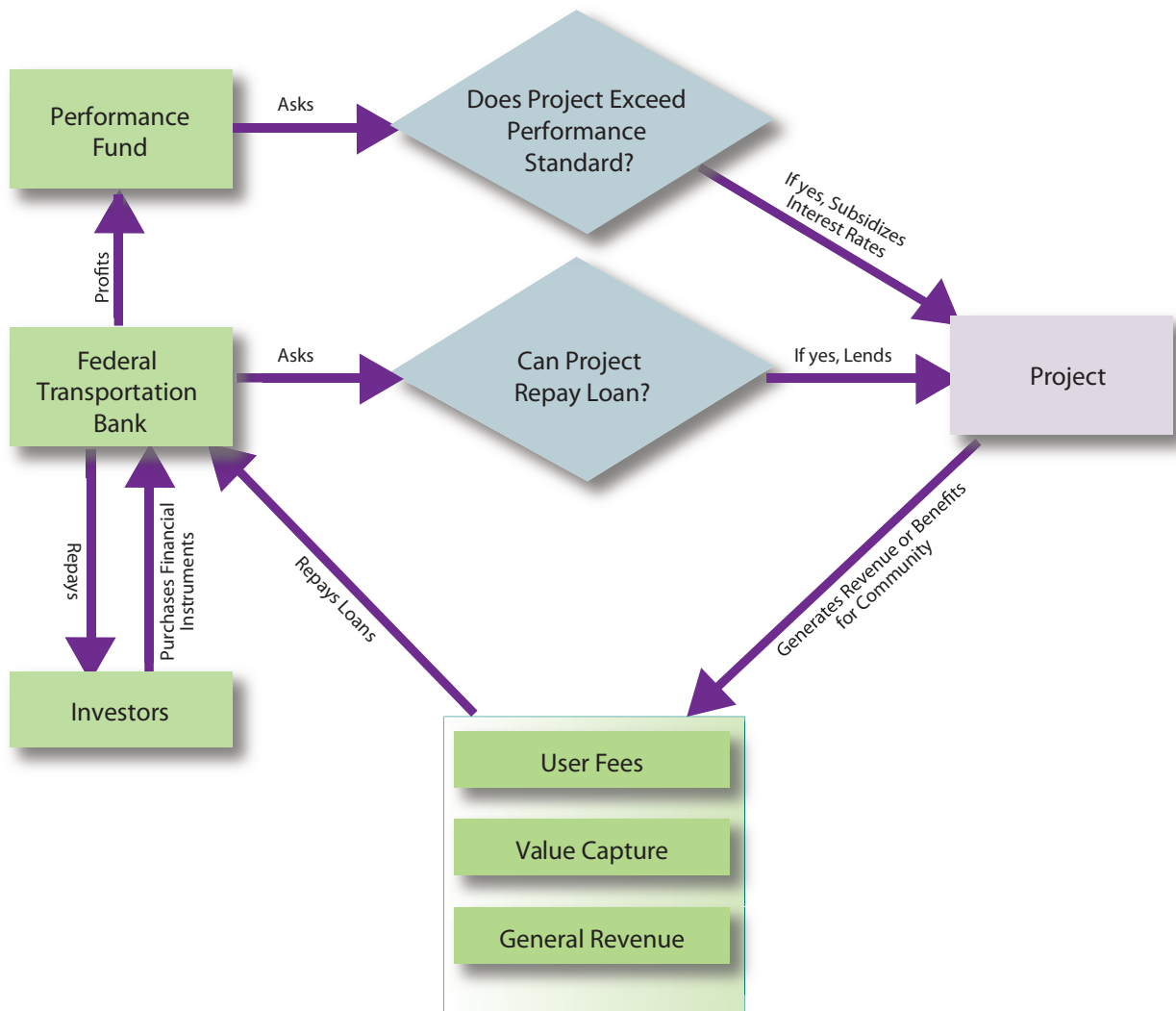


Figure 3.6: Expand-it-Second, Reward-it-Third. Source: (Kahn and Levinson 2011).

A BRIEF HISTORY OF THE IDEA 'FIX-IT-FIRST'

Great Artists Steal. – Pablo Picasso (attributed)

The term 'fix-it-first' has been in circulation for a few years. We do not know the first reference, though we can trace it to at least 2002, but it has taken off since August 1, 2007, the date of the collapse of the I-35W Mississippi River Bridge in Minneapolis. The bridge collapse was due to a design flaw that went undiscovered for four decades coupled with poor construction practices that exacerbated loadings immediately above the undersized gusset plate. While the proximate cause of the bridge collapse was not lack of maintenance, the collapse was revelatory in numerous ways about the state of that and other bridges. The bridge was known to be structurally deficient in other ways, and was fracture critical (a failure at a single point could result in failure of the structure as a whole). Many other bridges also had such problems.

Other notable users of the phrase include:

- Massachusetts Governor Mitt Romney³²

In January 2003, just days after being sworn in as Governor of Massachusetts, Mitt Romney stood alongside a structurally deficient bridge on Route 2 and said: 'Fix-it-first!'

³² (Grabauskas 2009).

- National Governors Association³³
- National Resources Defense Council³⁴
- Governor's Institute³⁵
- DCist³⁶
- US PIRG³⁷
- Sierra Club³⁸
- Environmental Defense³⁹
- EPA⁴⁰
- Transportation 4 America⁴¹
- The White House, 2012 Budget⁴²

³³ (Lambert 2004).

³⁴ (Benfield 2008).

³⁵ (Governors' Institute 2009).

³⁶ (Peppard 2007).

³⁷ (US PIRG 2007).

³⁸ (Sierra Club 2009).

³⁹ (Defense 2010).

⁴⁰ (Schor 2010).

⁴¹ (David 2011).

⁴² (US Office of Management and Budget 2011).

Adopts a 'Fix-it-First' approach for highway and transit grants, which will emphasize improving the condition of existing infrastructure. Consolidates 55 highway programs into five, to give States and localities greater flexibility to direct resources to their highest priorities and simplify operations.

4

Subsidy



Figure 4.1: Financially Sustainable Transit, Pacific Fair Mall, Gold Coast, Queensland, 2000. With fares like these, it must make money. Photo by D. Levinson.

Should government subsidize transport? If government subsidizes transport, should it subsidize producers or consumers? If a government gave money to consumers, they could spend it on what they want, paying for a service, which if it covers operating costs, could lead to more investment. If it gave money directly to producers, they spend it on more supply. Which leads to a better outcome?

Let's think about the word 'subsidy' for a moment. Below are a few examples.

1. If I buy a ticket on a train, and it pays my share of both the fixed and variable elements of the full cost of the trip, am I subsidizing the train? [No]

2. If my mom buys the ticket for me, is she subsidizing the train or subsidizing me? [me]
3. If my employer buys the ticket for me, is it subsidizing the train or subsidizing me? [me]
4. If a store buys the ticket for me, is it subsidizing the train or subsidizing me? [me]
5. If I buy a ticket which pays the marginal cost of my trip, but not the fixed cost, and my mom pays the difference, is she subsidizing me or the train? [the train]
6. If I buy a ticket which pays the marginal cost of my trip, and my city pays the fixed cost, is the city subsidizing me or the train? [the train]
7. If I buy a ticket which pays the marginal cost of my trip and the state pays the fixed cost, is the state subsidizing me or the train? [the train]
8. If I buy a ticket which pays the marginal cost of my trip, and the federal government pays the fixed cost, is the federal government subsidizing me or the train? [the train]
9. If the state gives me money and I buy a ticket which pays for the full cost of the train, is the state subsidizing me or the train? [me]

American Heritage dictionary says:

sub·si·dy n.

- Monetary assistance granted by a government to a person or group in support of an enterprise regarded as being in the public interest.¹

¹ The etymology comes from the Latin word *subsidiere* meaning “to settle down, stay, remain.”

Dictionaries imply that subsidy is primarily from a government. You can then decide what is government: Family? Homeowners association? City, state, and federal certainly apply.

This is relevant in transport accounting. For instance Amtrak, a publicly-owned corporation, gets a subsidy (which it calls ‘funding’) from the federal government.² If it were to declare that subsidy to be revenue, it would earn a ‘profit.’ (Apparently it once did, but does so no longer). Amtrak also gets subsidies from state governments. It does declare those subsidies to be revenues. If you think about it as providing a service to the states, this makes sense. Any contractor to the state which charges in exchange for a service books that revenue as income. So in Amtrak-accounting, state-supported services are ‘passenger-related’ revenue, but federal support is not.

² (Amtrak 2014).

We advocate reframing³ current US practice in transit subsidies

away from thinking of transit agencies as money-losing, and instead towards an organization providing services for users. Hopefully most of those users are passengers. It also would provide service for governments that want a particular service that users cannot pay for directly. The government would not be subsidizing the transit agency, it would be subsidizing users of the service by paying someone to provide the service. The difference in thinking is subtle, but important.

4.1 Car subsidies

In the United States (similar to many other nations), drivers do not pay enough for transport. As a result, drivers use too much and have misleading anchors about what prices ‘should’ be. When drivers are shown and charged the actual cost of things, they are surprised, and not a little bit disgruntled. They also often change their behavior.

Car2go is a carsharing company that has a presence in some US cities. We illustrate comparing their charges with costs of ownership.

CAR2GO VS. PRIVATE COSTS OF AUTO OWNERSHIP. Why should a car2go ride be \$0.38/*min*?⁴ We don’t pay \$0.38/*min* to ride our own cars, or transit, do we?

When driving our cars, we pay out-of-pocket for gasoline.⁵ At 48km/h,⁶ we pay \$0.05/*min* (assuming no variation in fuel economy).

Much of the other \$0.33/*min* is paying for what we perceive to be the fixed costs of vehicle ownership: the cost of the vehicle itself, insurance, maintenance, and repairs.

- The cost of the vehicle, say \$15,000 for a vehicle that runs 100,000 miles before depreciating to \$0, is \$0.075/*min*.⁷
- Insurance might run \$1,000/*year* or \$0.05/*min*.^{8,9}
- Vehicle taxes are about a quarter to half that, depending on where you are, so let’s say \$0.01/*min*. In some states these are dedicated to infrastructure, so we need to be careful to avoid double counting.
- Repairs, oil, and maintenance probably have a similar running cost to insurance, less in the early years, more in the later year (\$0.05/*min*).

Adding that together is \$0.185/*min*.

That leaves \$0.165/*min* in ‘out-of-pocket’ costs car2go charges above what you would pay for an equivalent vehicle. Some of this is



Figure 4.2: car2go in Minnesota. Photo by D. Levinson.

⁴ Note, rates vary by city, rates have changed since this was first written.

⁵ At prices of about \$0.92/L (inclusive of taxes), (\$3.50/gal) and 6.72 L/100km, (35 mpg) we pay just \$0.061/km (\$0.10 mi) out-of-pocket.

⁶ 30 mph

⁷ \$0.094/km (\$0.15/mi).

⁸ \$0.061/km (\$0.10/mi).

⁹ Pay as you drive (or pay at the pump) insurance is a long discussed policy that has yet to be mainstream in the US. A version exists in Australia and some other places, including some US opt-ins.

car2go operating expenses – load balancing or moving cars around so they will be near you, paying the cities for ‘free’ on-street parking, having a nice app and GPS. Some of this might be because car2go vehicles are actually used less than many private cars, so the fixed costs have to be spread over fewer minutes. Some of this might be higher insurance than you would pay. Some of this is on-road assistance as needed. Some of this is operating profit, a private company has to break-even as a business or it will cease to exist.¹⁰

¹⁰ Actually, car2go doesn’t have to break even, as it, like Smart, is a Daimler-Benz subsidiary, and car2go purchases Smart ForTwo, which offset less fuel efficient Mercedes cars under US Corporate Average Fuel Economy (CAFE) standards.

One point is the average user of car2go drives less than the average owner of an equivalent car, thereby saving the outlay of \$15,000 for ownership, \$1000/year for maintenance, \$1000/year for fuel, \$1000/year for insurance, and \$250/year for vehicle tabs. Thus when they are willing to drive, they pay more per minute than the per minute basis for an owned car because they are paying for the option value of having a car when they want, but not when they don’t.

The second point is if the average owner of a car paid an additional \$0.185/min on top of \$0.05/min, they would drive less. For a ten-minute trip, they would be out-of-pocket an extra \$1.85. For a thirty-minute trip, they would pay an extra \$5.55, which is about the out-of-pocket price of an express bus.

The costs so far only describe the private costs of driving. Since most of these costs are fixed, there is little reason not to drive once these costs have been paid. People would drive less, and potentially travel less overall, if they paid higher marginal costs of travel. This is one reason we don’t expect that car sharing will result in the same amount of vehicular travel as private vehicles.

Non-private costs

INFRASTRUCTURE. The full cost of travel includes non-private costs, including infrastructure. Nationally, direct user fees (gas tax and tolls) pay for about one-third the cost of all roads,¹¹ the other two-thirds comes from general revenue (particularly property taxes at local jurisdictions, but also pseudo-user fees like motor vehicle taxes). Since fuel taxes (the bulk of highway user fees) are \$0.0486/L¹² at the national level and \$0.0753/L¹³ in Minnesota, \$0.47 in total, we would need to about triple it for user fees to pay for all of infrastructure costs or \$0.02/min,¹⁴ of which \$0.0067/min is already covered by existing gas taxes, meaning a new tax of \$0.0133/min should be levied to convert road infrastructure costs into a user charge).

¹¹ (Henchman 2013).

¹² \$0.184/gal.

¹³ \$0.285/gal.

¹⁴ \$0.372/L (\$1.41/gal) or \$0.025/km (\$0.04/mi).

This assumes infrastructure spending is the right amount in total, about which there is considerable argument. Clearly much infrastructure is in poor condition or insufficient, which increases vehicle repairs, crash rates, congestion, and future infrastructure costs.

PARKING. Parking is usually ‘free’ where most Americans live and work and shop, so this is not an out-of-pocket cost until we start charging for parking.¹⁵ Obviously there is a cost that is bundled into other real estate transactions, or is subsidized by the infrastructure provider in the case of free on-street parking. The value of this land in alternate uses depends on location,¹⁶ and in most, but not all, US places approaches zero, though obviously this is not the case in active centers.

EXTERNALITIES. Like parking, this also does not include externalities, which are also ‘free.’ Crashes are mostly internalized in insurance, but congestion and pollution and CO₂ emissions and noise are not internalized. These estimates vary widely.¹⁷ This might be on the order of magnitude of \$0.10/min,¹⁸ though again varies hugely based on location and assumptions.

We have not also included user time. Presumably drivers consider their own time already (though undoubtedly over-estimate the time spent driving). At an average wage of \$20/hour (it is probably a bit higher) this would be \$0.33/min of labor foregone. Note this is roughly the same level as the full monetary costs of travel. In benefit/cost analysis, transport economists typically use half the wage rate, though this is at best a rule of thumb.¹⁹

...

Table 4.1 summarizes our ballpark out-of-pocket monetary costs per minute. Table 4.2 presents an estimate from extensive modeling by (Cui and Levinson 2019). Time is a dominant cost of travel, though we neglected it in the comparison above, as it applies to both car2go and a private vehicle. Access time (the time to reach the vehicle) is higher in a carsharing example than private ownership.

Reduction in travel

How much less travel would there be if the costs of driving paid out-of-pocket on a per use basis? Economists use the elasticity of demand with respect to price to estimate this. This tells us how much demand drops as prices increase. The short run elasticity of

¹⁵ (Shoup 2017).

¹⁶ §4.1.

Table 4.1: Summary Costs of Monetary Costs of Car Ownership (\$/min).

Category	Cost
Fuel	\$0.050
Vehicle ownership	\$0.075
Repairs, oil, & maintenance	\$0.050
Insurance	\$0.050
Infrastructure (ex. gas tax)	\$0.013
Externalities	\$0.100
Total	\$0.34

¹⁷ (Levinson and Gillen 1998; Parry et al. 2007).

¹⁸ \$0.12/km (\$0.20/mi).

¹⁹ (Hensher 2019).

Table 4.2: Average Cost Estimates for Each Cost Component Among All the Links on the Twin Cities Road Network (\$/veh – km). Source: (Cui and Levinson 2019).

	Single Cost Components				Full Cost
	Time	Safety	Emission	Money	
Internal	0.3819	0.0399	0.0009	0.2194	0.6785
External	-	0.0227	0.0192	0.0359	

demand for driving (measured in vehicle miles traveled) with respect to the price of gas is about -0.05, meaning for every 100% increase in the price of gas, there is a 5% decrease in gasoline consumption (which correlates to driving in the short run, in the long run there is also a shift in vehicle fuel economy).²⁰ So if we hold that to be true for all costs, going from \$0.05/min to \$0.34/min is 676% higher cost (a 576% increase), leads to about a 29% reduction in fuel use (distance traveled) in the short run if people paid their roughly fixed costs plus infrastructure plus externalities of vehicle ownership as variable costs instead. Of course at the magnitude of shift, the elasticity values may no longer hold. In any case, this is no small matter. Certainly the direction is right, countries with much higher fuel taxes see much less driving in general.

²⁰ (Hughes et al. 2006).

Economic responses

INCOME EFFECTS. There would be a countervailing income effect, as people now had an income that was higher by the cost of the car-payment (say \$1,500 per year over 10 years), and \$2,250 in other vehicle costs. That additional income effect would be expended consuming many different goods, not just travel by automobile. A fraction of it (maybe 20-30%) would go back to pay for additional transport, though not necessarily more travel, perhaps just nicer travel in a better car (a Smart ForFour instead of a Smart ForTwo). Since wealthier people travel a bit more than less wealthy, there would be a small bit more travel, but probably a relatively *de minimis* amount.

INDUCED DEMAND. Further, if we did reduce congestion, we would expect at least some people to take advantage of that change and start traveling more than they otherwise would have. There would be induced demand²¹ due to the lower travel times.

²¹ §14.

TIME IS MONEY. As the adage goes, 'time is money,' and if we were more directly aware of the cost of our travel, we would spend far less on it. This implies we over-consume travel compared to a system that charged users directly for their full costs. As we move towards more efficient and equitable transport funding, using road pricing, and an economy with shared vehicles and Mobility-as-a-Service (MaaS)²² we should expect significantly less passenger travel demand.²³

Consequently, infrastructure providers should supply less transport capacity in this policy environment than one where people could free ride and over-consume. Since infrastructure is long-lived, planning for a smaller network should begin now, with the aim to avoid irreversible investments made today that will later be seen as unnecessary.

One area that has received some attention for adaptable infrastructure is parking structures. Parking is required as part of new development in most of the US, yet demand for parking will decline if on-demand services (including automated vehicles) increase. Some architects and developers are already designing parking structures for potential future transition to some other use.

Hidden subsidies

Highway users pay a fee for the cost of highways. Federal gas taxes are dedicated to the federal Highway Trust Fund (HTF), and many states have similar rules at the state level. The HTF has in recent years fallen short of the amount that politicians want to spend on roads, but that is in principle easily corrected with an increase in the user fee or a decrease in spending. Most local roads (municipal and county) are paid for via local general revenue. This is also well known in the transport community, if not the general public.

The hidden subsidy is in states which have general sales taxes, but don't apply them to gasoline.²⁴ In Minnesota, for instance, purchasers pay a sales tax on prepared food, but not gasoline (or clothing, or a few other random things). Thus relatively, spending is encouraged in those untaxed areas, which are 6.875% less taxed than other goods. This lack of a tax is not a subsidy in a state which doesn't tax sales, and instead taxes income or property. But where sales are taxed, but gasoline is exempted, other goods are implicitly taxed more so gasoline can be explicitly taxed less. Note this is not universal across the US.

In California, there has long been both a sales and use tax. However the value of the sales tax on gasoline is now lower than the sales tax on general goods, though for many years it was close

²² Different authors mean different things by 'Mobility-as-a-Service'. We refer to car sharing, ride hailing, bike sharing, taxi, and cloud commuting type services. Some people think that there should be single app with a single mobility account, which allows using different types of mobility services for a single monthly charge. That definition is too restrictive in our view.

²³ Were the marginal costs of travel to increase travelers may change vehicles, switch travel modes, relocate, telecommute (or not travel at all) or increase demand for deliveries.

²⁴ The magnitude of this problem is complex, as of 2012, 16 states have sales taxes on motor fuels, but most of those states dedicate funds to roads (and thus not to other purposes, and thus cannot be considered user fees), see (Workman and Rall 2012) for explanation.

or the same. There is argument about the fact that the sales tax is levied on both the gasoline and the user fee associated with the gasoline. In short, the general principal is that gasoline cannot simultaneously be taxed with the funds dedicated to highways (thus acting as a user fee) and exempted from sales taxes without there being a subsidy that at least partially offsets the user fee. At a \$0.66/L²⁵ price of gas, a 6.875% tax raises \$0.0458/L.²⁶ To compare, the state gas tax is \$0.0635/L.²⁷ Thus, in Minnesota the net state user fee is only about \$0.0178/L,²⁸ not the \$0.06356/L²⁹ widely advertised. The federal gas tax is \$0.041/L.³⁰ This is more truly a user fee. Also since there is no federal sales tax, gasoline is not disproportionately favored. The tax in Minnesota is higher in some localities to pay for other things. We could similarly look at the motor vehicle sales tax (MVST), which is dedicated to transport in Minnesota. It is 6.5%. There is nothing wrong with dedicating the funds, but as a result, they cannot be counted as user fees, since sales tax revenue would otherwise go to general revenue. Since 2011, 60% of the MVST goes to the Highway User Tax Distribution Fund, and 40% goes to the Transit Fund.³¹

²⁵ \$3.00/gal.

²⁶ \$0.20625/gal.

²⁷ \$0.286/gal.

²⁸ \$0.08/gal.

²⁹ \$0.286/gal.

³⁰ \$0.184/gal.

³¹ (Minnesota Department of Revenue, Tax Research Division 2006).

To minimize distortions, the general sales tax should apply to all goods equally. For equity concerns, sales taxes can be refunded, or at sale can be avoided with specialized payment cards. Better, a value added tax should be used. Special taxes on beneficiaries should be used where they can be, but not in lieu of general taxes. There is sufficient economic capacity in the highway system for users to pay for the whole thing (the evidence being how much people have paid for gasoline per gallon in the past in the US, and how much they pay in other countries), it's a shame we don't take advantage of that.

After paying for roads, and their externalities, and their share of the general tax burden, road users will be paying about their fair share. Taxes are needlessly complicated by special interests. This allows all sorts of hidden subsidies. Let's expose them to the sunlight, and then make objective decisions about whether we should lower the general sales tax on all other goods, and impose that tax rate on fuel.

Road rent

There are a number of ways to view the cost of automobile travel. For instance in this book we examine the congestion costs imposed, we allocate infrastructure costs, and assess full costs to consider internal costs, subsidies, and externalities. This section examines the idea of road rent, which considers the opportunity cost of land used for

roads. At the margins, what is the value of road space for parked and moving cars, and how might that cost look on a per vehicle-km traveled basis?

LAND HAS VALUE. Land used as roads has value both as a road and potentially for other uses. What if the value for other uses was higher than that for use as a road?

In Greater Sydney land values range from to \$AU210,000/ m^2 in Barangaroo on Darling Harbour to under \$AU1000/ m^2 in Western Sydney.³² In Minneapolis, we estimated a few years ago that average assessed land value as \$144/ m^2 for streets and \$30/ m^2 for highways.³³ It seems that assessed value is about 2/3 of market value in Minneapolis.

³² (Metcalf 2018).

³³ (Junge and Levinson 2013).

In some places it is much higher, in some places much lower, the examples used herein are simply an illustration.

The idea is that there is a land holder (such as a government land agency) that has to decide whether to allocate land to road uses or for other purposes.

CHARGE RENT FOR ON-STREET PARKING. Consider a typical suburban residential neighborhood with 'free' parking in front of houses. The land is valued at \$1,000/ m^2 . Each house requires one parking space out front, and parking is permitted 24 *h/day*. Conservatively, a car takes 10 m^2 when parked (the road is the access lane, we consider that separately). It would cost \$10,000 for the land owner to purchase the land equivalent of the parked car. The annual rent on that would be \$400 (at 4% interest).

In this example \$400 is how much the car owner should pay annually to their municipality for a permit to park their car to cover the cost of land (not the cost of infrastructure, or any other costs of roads and mobility, just the cost of land). This is a bit more than \$1/*day*.³⁴ In more expensive neighborhoods, this would be higher, in less expensive neighborhoods, lower. For Minneapolis, we have previously estimated about 220,000 on-street spaces.³⁵ At \$400/*space/year*, this would raise \$88,000,000/*year*, a not inconsiderable share of the city's \$1.3 billion annual budget.³⁶ Instead it is mostly given away free.

³⁴ More precisely \$1.095/*day*.

³⁵ (Levinson et al. 2018).

³⁶ (City of Minneapolis 2017).

Consider the implications if property taxes were reduced by up to \$88 million in total, and parking permits sold at \$400/*year* (payable monthly with the water and trash bill). People would realize the cost of on-street parking, and there would be less demand for it, and less vehicle ownership at the margins, and fewer trips by car. Space freed up could be re-allocated.



Figure 4.3: Illustration of space occupied by cars. Note that most cars do not have 2 occupants. This particular layout is, surprisingly, in somewhat congested conditions. Cars often take up more space at higher speeds. Screen still from a 2002 Saturn car company TV commercial. Image source: The San Francisco ad agency Goodby, Silverstein & Partners. (Raine 2008).

Alternatively, \$400/year is the value of public subsidy from publicly-owned land to private car owners who get 'free' on-street parking. In short from the car-less to the car owners.

ROAD SPACE HAS ALTERNATIVE USES. The economic idea of opportunity cost is important here. Opportunity cost is the value of the next best alternative. The next best alternative to road space might be renting it out. For instance, an urban US freeway that destroyed blocks of extant development when it was built has an opportunity cost associated with the value of that real estate.

So the question arises as to what other uses could be made of the road; for if there were no other uses, you might as well store cars for free. Here are several other uses that could be considered to replacing a parking lane:

- Park or parklet,
- Bike lane,
- Bus lane,
- Paid parking, via meters,
- Shared car parking (rented to the car sharing company),
- Shared bike parking (rented to the station-based or dockless bike sharing company),
- Taxi or ride-hailing stand,
- Bus stop,
- Shared scooter parking (rented to dockless scooter sharing company),
- Food truck or ice cream vendor,
- Road for moving motor vehicles (a parking lane could be another moving lane),
- Sold off for development.

The last item deserves some discussion. Consider that our road with two parking lanes (one on each side) is maybe 10 or 12m wide.³⁷ This is wider than some houses are long. The city could in principle retain the sidewalks and sell off the roadbed for townhouses or single family homes. Given the houses are already serviced by alleys, and so long as not all roads were sold off, some roads could be. An illustration of this is the Milwaukee Avenue in Seward in Minneapolis, as shown in Figure 4.4. You will see there is no paved street in front of the houses. This could be tightened up further or realigned should there be demand.

This is not appropriate for every street. However, (1) there are places this can be done, where roads are in excess and housing scarce, and (2) this illustrates that land currently used as asphalt to store and move cars has value, and that houses have value even in the absence of streets for cars in the front.

³⁷ About 32 to 40 ft.

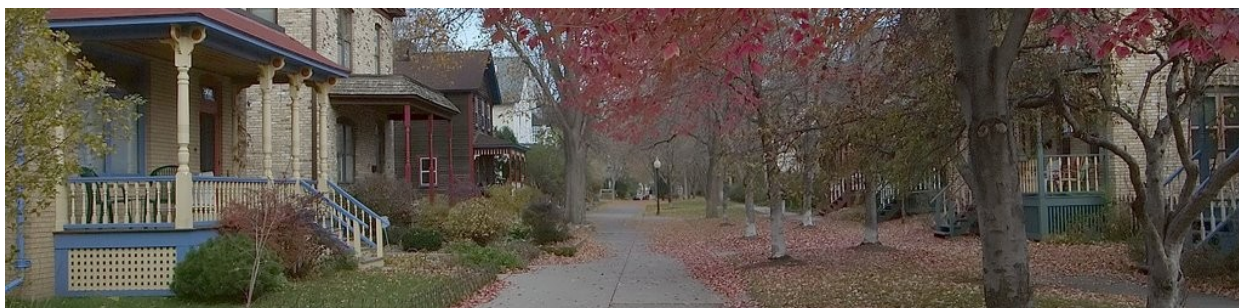


Figure 4.4: Milwaukee Avenue, Seward. Source: (Milwaukee Avenue Historical Association 2014).

There are always excuses – utilities may need to be relocated, fire trucks would need to go slower down narrower sidewalks. But these excuses can be overcome, there are numerous examples of narrow paths that function as roads.

CHARGE RENT FOR MOVING CARS. Typically each car is in use 1 - 1.5 hours per day, and parked for the remainder. Above, we considered parking, the ‘remainder,’ here we look at the time in motion.

When in use, the car is occupying not simply its area,³⁸ but also is preventing the use of other space around it. On a freeway with a capacity of 1,800 vehicles/hour traveling at a freeflow speed of 100 km/h, (i.e. just before the speed and flow drop due to congestion sets in) there is a critical density of 18 vehicles/km.³⁹

It is the density that is the relevant number here, since vehicles are occupying space that we are charging rent for in this thought experiment. Though they are moving, and so the space they are occupying moves with them, there is always some space being occupied for the duration of their travel. Each of those vehicles per hour is occupying a moving window of space.

ROADS ARE A TIMESHARE. When roads are less congested, cars are consuming more space per vehicle. So uncongested urban roads are much more expensive per traveler than congested rural roads. When traffic breaks down, they are consuming less space, but presumably are occupying that space for more time, since they are going slower. Induced demand,⁴⁰ and travel time budgets⁴¹ negate that to a significant extent.

In this example, the hourly rent on 200 m² is what we are interested in. Though cars move, over the course of 1 hour of travel in these conditions, they are claiming that much space. The specific space they are claiming moves with the vehicles, but this all balances out as other cars claim the space they vacated.

³⁸ The 10m² = 2m · 5m.

³⁹ 18 vehicles/km is 55.5m/vehicle. Lane width is 3.65m, so the area occupied is 202 m². Let's round to 200 m². Each moment a car is in use, it is using 200 m², on which it should pay rent. So for an hour a day, this is 720,000 m² · s. Or 72 hectare · s. Note: 1 are = 100 m² and 1 hectare (ha) = 100 are = 10,000 m². The m² · dotsec (or the larger hectare · second) is a new unit of measurement (a time-volume) that needs a catchier name.

⁴⁰ §14.

⁴¹ (Levinson et al. 2018).

Empty roads still have to be paid for, and paid for by actual road users. Even when a road is not being used, it is available to be used. Travelers have the option of traveling. Pavements cannot be easily be rolled up and allocated to other purposes on the fly, particularly purposes like buildings. (Roads can occasionally be closed for special events, but this is rare during business hours.)

⁴² l = length (km), w = lane width (m), v = velocity (km/h), q = flow (veh/h), k = density (veh/km), $AADT$ = Average Annual Daily Traffic, p = land value (\$/m²), i = interest rate = 0.04, y = year, r = land rent (\$/y/m²), d = days/year

EXAMPLE. Consider a car trip that uses three roads:⁴²

- Road section 1 (suburban residential):

$l = 5 \text{ km}, w = 3.65 \text{ m}, v = 30 \text{ km/h}, q = 1000 \text{ veh/h}, k = 33.33 \text{ veh/km},$
 $AADT = 10,000 \text{ vehicles/day/lane}, p = \$1,000/\text{m}^2.$

- Road section 2 (motorway):

$l = 10 \text{ km}, w = 3.65 \text{ m}, v = 100 \text{ km/h}, q = 2000 \text{ veh/h}, k = 20 \text{ veh/km},$
 $AADT = 20,000 \text{ vehicles/day/lane}, p = \$5,000/\text{m}^2.$

- Road section 3 (downtown):

$l = 1 \text{ km}, w = 3.65 \text{ m}, v = 40 \text{ km/h}, q = 1600 \text{ veh/h}, k = 40 \text{ veh/km},$
 $AADT = 16,000 \text{ vehicles/day/lane}, p = \$10,000/\text{m}^2.$

⁴³ With heterogenous traffic, this is obviously far more complicated, and we would make use of the q , k , and v variables to compute an area-time.

Consider each road section to be a homogenous pipeline.⁴³

The annual rent (R) for each road section is the $R = p \cdot i \cdot l \cdot w$

- Road 1: $R = \$1,000/\text{m}^2 \cdot y \cdot 0.04 \cdot 5,000\text{m} \cdot 3.65\text{m} = \$730,000/y$
- Road 2: $R = \$5,000/\text{m}^2 \cdot y \cdot 0.04 \cdot 10,000\text{m} \cdot 3.65\text{m} = \$7,300,000/y$
- Road 3: $R = \$10,000/\text{m}^2 \cdot y \cdot 0.04 \cdot 1,000\text{m} \cdot 3.65\text{m} = \$1,460,000/y$

This annual rent is paid by the road agency to the land owner for the use of land as a road. The road agency then wants to recover this cost from its customers, the travelers.

The question of how to allocate always has some subjectiveness to it. Another way of thinking about it is based on elasticity of demand.⁴⁴ Peak hour work trips are perhaps the least elastic (least sensitive to price), and so from an economic efficiency perspective should bear the greatest cost.

In this example, we take a simpler tack.

The allocation is $R/AADT$ to get cost per year per daily tripmaker, and divide by 365 to get cost per trip, and by section length to get cost per km. In this example:

- Road 1: $\$730,000/10,000 = \$73/y = \$0.20/\text{trip} = \$0.04/\text{km}$
- Road 2: $\$7,300,000/20,000 = \$365/y = \$1/\text{trip} = \$0.10/\text{km}$

⁴⁴ This is formally called Ramsey Pricing, see (Oum and Tretheway 1988).

- Road 3: $\$1,460,000/16,000 = \$91.25/y = \$0.25/trip = \$0.25/km$

The total is thus \$529.25 per year or \$1.45 per trip to cover land rent.

THE IMPLICATIONS OF ROAD RENT ARE SEVERAL

- At an additional \$1.45 per trip, travel by car (and congestion) will diminish.
- Road rent is essentially additive with annualized infrastructure costs. Infrastructure budgeting generally does not consider the cost of land, rather, land is often implicitly considered 'free' or a sunk cost.
- If travel by car diminishes sufficiently, road space can be clawed back and redeployed for other public purposes.
- Narrower lanes impose less road rent. But not necessarily proportionately so, as the throughput on narrower lanes (with human drivers) may be lower as drivers are less keen to be immediately adjacent to nearby high-speed vehicles.
- Slower moving vehicles take up less space, but take that space for longer.
- While pedestrians and bicyclists use space as well, they use much less space.⁴⁵ Sidewalks (footpaths) are often considered part of the adjacent private property, and are thus already paid for with property tax.
- Land used for roads instead of development is not on the books for property taxes.
- The revenue raised can be used for many transport purposes or redistributed back to taxpayers through some other means.
- The additional road rent reduces the effective land rent that landowners can charge. If people have to pay more for travel, they will pay less for real estate.
- Rural areas have much lower, perhaps negligible, road rent. Though the number of users drops significantly (so there are fewer travelers who must pay the burden of road rent), the cost of land drops even more significantly.
- Were there no (fewer) roads, land would also have very little (less) value, since it would be difficult to access and egress.

⁴⁵ See discussion of flux in (Levinson et al. 2018).

Table 4.3: Mode Share in the US, Weighted by Person Distance Traveled. Source: 2017 National Household Travel Survey.

Mode	Share	Mode	Share
Car, SUV, Van, LT, RV, MC	75.8	School bus	1.0
Walk	0.8	Bicycle	0.2
Taxi, Limo, Ridehailing	0.4	Rental car, Car sharing	0.5
Public Transit	1.8	Paratransit, Dial-a-ride	0.1
Intercity bus, Charter	0.6	Amtrak, Commuter rail	0.9
Airplane	16.8		

- If roads were fully built on, views would be terrible and the existing buildings would diminish in value. But none of that is to say we have the correct amount of roads now. Clearly urban roads are undercharged in a real estate sense.

4.2 *Bicycle subsidies*

This book largely focuses on two transport modes: the automobile/truck/highway system and public transport, and pays short shrift to walking and bicycles, which tend not to have large funding demands, nor in the case of bikes, large usage in the US, as shown in Table 4.3.⁴⁶ Bicycles also don't have user fees.⁴⁷ Concomitantly bikes don't have much infrastructure to show for it.

Certainly, as shown elsewhere, car owners don't pay for 100% of the cost of road infrastructure (more like 50% of operating and capital costs, but depends how you count), but they pay more than non-car owners due to gas taxes and vehicle registration fees. For better or worse, this allows a lot of car-oriented infrastructure to get built.

Transit users don't pay for 100% of the cost of riding transit (farebox recovery is nearer 33% of operating costs and 0% of capital costs), but they pay more than non-transit users due to fares. This allows transit routes to be somewhat more widespread than otherwise.

There is a perception widely held among non-bike riders that bicyclists are free riders. Bike riders do not pay more for the available bike infrastructure than non-bike riders. Is this perception wrong? Bicyclists could step-up (or pedal-up) and claim some rights and funds in exchange for some responsibilities and paying user fees.

Bicycling would get more respect at the table, and more resources, if bicycle owners and/or users paid some amount of money to support bicycle infrastructure.

⁴⁶ Author's note: David Levinson walks to work in Sydney, and did so in Minneapolis; David King bikes to work in Phoenix, and walked when he lived in New York.

⁴⁷ While not a user fee, in 2017 the State of Oregon added a \$15 tax on bicycles over \$200 to fund new bike infrastructure. (McLeod 2017).

For instance, a \$10/*year* fee for registering a bike would raise more than a million dollars a year in Minneapolis, which would go a long way toward bike infrastructure. Bike advocates should reframe and embrace. A Bicycle Trust Fund could be very powerful.

Some suggest the funds for bicycle infrastructure should be provided by the public out of general revenue. Our first thought is, how is that working for you so far? If you are happy with the level of bike infrastructure in America's number one bike city, Minneapolis, much less everywhere else, carry on. If you think it should be better, you can rally and exhort, but you can also bring some money to the table.

In contrast to sidewalks, which are largely maintained (or not) by adjacent property owners, and paid for from special assessments, bike paths are treated more like roads. Also, keep in mind, everyone walks, not everyone bikes.

Tax collection bureaucracies have high overhead, but there should be ways to do this and get a pot of money together. If you think a \$10 annual fee is too administratively complex, make a \$30 fee at the point of sale and/or at bike registration. Exclude bikes older than 3 years.

If you think the bike-tax cops will harass poor or minority bicyclists, a very real concern,⁴⁸ make it a secondary rather than primary offense, so riders can't get pulled over for it.

If you are worried about kids, set it up so parents pay for kids, or make it only for bikes with a greater than 20 inch wheel – there are many possible strategies.

We need to think creatively.

⁴⁸ (Wisniewski 2017).

4.3 *Transit subsidies*

The words 'transit'⁴⁹ and 'crisis' have been associated in the American lexicon for nearly 60 years. It is time to recognize this as a chronic condition rather than a temporary event.⁵⁰ Current strategies have not placed transit on a financially sustainable path.

In most of the United States and much of the world, public transport is publicly subsidized. Everyone in an area pays for transit whether or not they use it. This was not always the case, and need not everywhere be the case. Once mass transport was privately provided to the public for profit (in most US cities) from the late 1800s through the first half of the 1900s. While rights-of-way were often publicly provided, the companies operating transit paid for the maintenance of those rights-of-way above and beyond what was required for transit. This model was hugely profitable for decades,

⁴⁹ The terms 'mass transit', 'public transit', and 'public transport' are used interchangeably and refer to services that carry multiple parties from multiple origins to multiple destinations.

⁵⁰ See (King 2013).

⁵¹ (Lave 1994).

until it wasn't. In fact, as late as the 1960s over 80% of mass transit in the United States was privately owned and operated.⁵¹

The causes for transit's decline are many, but rising incomes, suburbanization, and of course a much faster competitor in the automobile/highway system are among them. Operational reasons include limits to raising the nickel fares starved the operators of money to invest in the systems and diminished performance due to travel in mixed-traffic. Between the 1930s to the 1960s, depending on where you were in the United States, the private sector abandoned mass transit and the public sector took over.

Over the past half century, US transit under public ownership has seen an enormous and growing per passenger subsidy. The debate over the merits of subsidy has become partisan.

Transit is essential to those who use it on a daily basis. But so are many other goods and services that have much lighter public involvement, ranging from food production and distribution to electricity and natural gas. Aside from the inability of transit operators to make money under the regulatory regime of 60 years ago, is there anything about transit that warrants public ownership? Let's consider who benefits from transit:

- Riders, who on average directly pay about one-third of the operating costs through fares, and none of the capital costs
- Employers of subsidized riders, who can pay lower salaries since those employees have some of their transport costs covered. In some places, employers subsidize transit passes or local transit services for employees.
- Highway travelers who face less congestion the more other people use transit. The federal Highway Trust Fund, most of which comes from motor fuel taxes, dedicates 2.86 cents of the 18.3 cent federal gas tax (or 16%) to transit capital costs. Many states have similar transfers from highway users to transit systems. To be clear, the purpose of transit is transport for people who use transit, not less congestion for people who don't.
- Land-owners whose value appreciates due to the option value provided by transit, even when they themselves, or their tenants, don't use it.
- Society as a whole, which has fewer pollution externalities if more people ride transit instead of driving alone in gasoline powered automobiles.

All of these beneficiaries pay something, but they do not pay in proportion to the benefit, because of the misperception that mass

transit is a [public good](#),⁵² like police or fire protection. In principle, a public good is something that people cannot be prevented from using, and that does not get worse the more people it serves. In reality, transit is more like a club since we charge users all the time. In fact, it would be technically fairly easy to charge users more. ⁵² §A.

The fear is that if users paid more, they would ride transit less. Undoubtedly in the short run, if nothing else changed, a fare hike would lead to a decrease in ridership. Yet many countries (including Canada) have higher transit fares (and higher costs for competing modes) along with higher transit ridership (and better service). With exchange rates and complicated fare structures, however, there is no perfectly fair comparison.

There is also the concern that transit is a merit good, so it is aimed at serving poor passengers who cannot pay the average cost of transit service. Overall, transit riders have lower than average incomes. Yet many routes (think commuter rail and heavy rail systems) have passengers with higher than average incomes. As we discuss below, if you want to help poor people, give them money; or, failing that, give or subsidize transport vouchers or transit passes, rather than subsidizing the wealthy under guise of aiding the poor.

But the primary problem with funding transit operations is not that poor people are subsidized. Since the routes serving low-income travelers are often profitable (fares cover operating costs), it is that long-distance, inefficient suburban routes are very heavily subsidized by profitable or near-profitable urban routes. If the average farebox recovery in the US is one-third (as shown in Table 4.4), many routes are much higher and other routes are much lower. The lowest performing routes are typically in suburban districts, where transit dollars are spent as part of a political bargain to obtain some form of general revenue funding from suburban jurisdictions.

An independent transit utility can raise fares, with the approval of a public utilities commission. For a private firm, we would expect that total revenues exceed total operating costs. The ratio of revenues to operating costs is called ‘farebox recovery’.

Playing with this idea more deeply, we engage in two thought experiments. The first considers this idea of full farebox recovery, and what does it mean, and the second looks at a radically different alternative: free transit.

System	Rate (%)	System	Rate (%)	System	Rate (%)	System	Rate (%)
<i>Asia</i>		<i>USA</i>		<i>USA</i>		<i>Australia</i>	
Hong Kong MTR	124	Amtrak	95	San Antonio (VIA)	12	Canberra	21
Osaka (Hankyu Railway)	123	Atlanta (MARTA)	30	San Diego MTS	39	Sydney	27
Osaka (OMTB)	137	Austin (CMTA)	10	San Francisco (BART)	70	Melbourne	30
JR East	84	Boston (MBTA)	30	Oakland Airport Connector	96		
Tokyo Metro	119	Chicago (CTA)	55	San Francisco (Caltrain)	63	<i>New Zealand</i>	
Tokyo Toei rail services	74	Chicago (Metra)	43	San Francisco (SFMTA)	35	Christchurch	35
Taipei Metro	100	Cleveland (GCRTA)	18	Santa Clara County (VTA)	10	Dunedin	60
Kaohsiung MRT	83	Dallas (DART)	14	So. Cal. (RRA)	42	Hamilton	34
Singapore (SMRT)	101	Detroit (DDOT)	20	Staten Island (MTA)	15	Wellington	57
Beijing Subway	59	Harrisburg, PA (CAT)	17	Washington, DC (WMATA)	42	Auckland	44
		Las Vegas Monorail	56				
<i>Europe</i>		Long Island (MTA)	50	<i>Canada</i>			
Amsterdam (GVB)	88	Los Angeles (LACMTA)	23	VIA Rail	51		
Rotterdam (RET)	80	Maryland	23	Brampton (BT)	46		
Berlin	70	Miami-Dade Transit	21	Calgary	50		
Brussels	35	Minneapolis - St. Paul	25	Edmonton (ETS)	39		
Copenhagen	52	New York City (MTA)	47	Mississauga (MiWay)	46		
London Underground	107	New York City (NYC Ferry)	29	Montreal (STM)	46		
Catalunya (FGC)	93	New York (Metro-North)	60	Ottawa (OC Transpo)	45		
Madrid	41	New York (PATH)	44	Quebec City (RTC)	39		
Milan	28	New Jersey (NJT)	45	Toronto (TTC)	70		
Munich	70	Orlando (Lynx)	24	Toronto (GO Transit)	77		
Prague (DPP)	53	Philadelphia (SEPTA)	38	Vancouver TransLink	55		
Paris (STIF)	30	Pierce County, WA	30	Winnipeg	60		
Stockholm	37	Philadelphia/ (PATCO)	49				
Rome	36	Portland (TriMet)	30				
Vienna	48	Seattle (King County Metro)	35				
Helsinki	49	Seattle (Sound Transit)	42				
Zurich	60						

Table 4.4: Farebox Recovery Rates. Source: (Wikipedia contributors 2018c).

Thought experiment: full farebox recovery

Public transport in the US is heavily subsidized. Regardless of whether this is a good thing, is 100% transit farebox recovery even possible, or will a death spiral result in no users? This section engages in a thought experiment to test what kinds of fares and user subsidies would be needed to achieve 100% farebox recovery.

If 3 million people in the Twin Cities metro each purchased a Metropass at \$76 per month, that would be \$2.736 billion per year (about 9 times the current annual budget). This is highly unlikely on a voluntary basis, the evidence for which is that we have not yet seen it.

According to the Minnesota Department of Transportation total budgets are \$301 million per year on Metropolitan Council systems for bus and LRT (excluding other services), so really only 330,000 pass-holders would be required to cover existing costs. This is just an order of magnitude estimate, and certainly high since while a large (but unknown) fraction of existing riders are essentially daily riders, others are more infrequent riders and would still pay fares rather than get a pass. The problem is that there are not 330,000 daily or near daily users of the system, instead there are 267,700 daily trips for Metro Transit, and a few more for suburban transit

systems.⁵³ Presumably about half that many persons ride daily, assuming mostly round trips, and one round trip per day. This is further complicated by transfers.

Working this problem in reverse to cover \$301 million dollars in expenditures from 267,700 trips (or 133,850 riders, assuming round trips and no transfers) requires \$2,250 per person per year⁵⁴. But if fares increased to the equivalent of about \$3.10 per trip (at 60 trips per month), there would be fewer users.

How many fewer users?

⁵³ These suburban systems are referred to in the Twin Cities as 'opt-outs' since they opted out of Metro Transit service.

⁵⁴ \$187 from each person who rides per month

SCENARIO 1. If users were now paying \$2.25 per trip in fares (two-way peak) and it increased to \$3.10, that is a 39% increase in effective user prices (though this is complicated by switching from an out-of-pocket fare payment to a monthly pass). At an average fare elasticity of -0.4, we would expect a decrease in ridership from 133,850 travelers each day to 114,000.⁵⁵

Total revenue drops to about \$255 million per year.

Nevertheless, if Metro Transit could reduce costs by \$46 million without reducing service, good on them! That is however unlikely, and we see aspects of the transit death spiral in place: Fewer riders -> Less revenue -> Reduced Service -> Fewer Riders. This might be self-limiting, as the weakest services affect the fewest number of riders.

Alternatively, we could just keep raising prices until we reached equilibrium. This reduces revenue and thus requires a rate increase, which further reduces riders. This is also self-limiting, and in this scenario the system ridership drops to just over 100,000 persons per day (200,000 trips per day) at an annual Metropass rate of \$2,988.

⁵⁵ (McCollom and Pratt 2004).

SCENARIO 2. A current farebox recovery ratio of 0.31 suggests riders are not in fact paying an average of \$2.25 per trip. Instead, it is about \$1.91/day or \$0.95 per trip equivalent. Certainly some riders pay 'full freight.' Other have passes and use more than the average number of trips than a pass is equivalent to, ride in the off-peak, or otherwise have discounts. Thus increasing to \$3.10 for everyone would be more than a 40% increase for some. In this case, we would need to increase fares from \$1.91/day to \$6.17/day, a 223% increase. If riders actually were expected to pay this, ridership would drop about 90%. Then to continue full service (though why would we?), we would need to increase daily rates to \$56.22. This would reduce ridership to about 0. This is the full transit death spiral in action.

There is a middle ground, retrenching service to that which is profitable, which would lose riders and service, but hopefully lose more costs than revenues.

Clearly we cannot uniformly more than triple real transit fares as paid by patrons, in the absence of changing other costs in the transport system, and expect the current set of riders to pay that.

A plausible policy would argue for 'equity subsidies' to cover the difference for groups that society wants to provide aid to rather than discounting fares for everyone alike.

Thought experiment: free transit

The foremost response to the thought experiment on farebox recovery is that transit should be free. So why don't we treat transit like we treat elevators? Functionally they appear very similar, though one operates on the horizontal and the other the vertical.

There are several answers.

- Sometimes we do charge for elevators, and while this is admittedly rare, the cases are informative. The Empire State Building charges users going to the observation deck, because the users of the elevators are not paying rent in the building the elevator serves and are not doing business with those who are. Whether we are charging for the elevator or the view is not always obvious. There is also an unpopular charge for some elevators in China.⁵⁶ The custom is of course that elevators (like parking in most places in the US) is bundled into the rent. The custom is not without reason, charging for elevator riders, like charging tolls on drivers, or fares to riders, is an annoyance. The mechanics are perhaps trickier, if you don't have anyone collecting the fare, do you have to have a turnstile at the elevator, or just the first person who boards has to pay and everyone else free-rides. Staffing the elevator is unnecessary. The honor system would likely break-down, and proof-of-payment engenders an enforcement problem. Also the marginal costs of elevators are approximately zero.
- Sometimes we do give away transit, though this is rare as well, and the cases are also informative. For instance, we give away transit when there is a patron who views most of the riders as 'us' rather than 'them.' That is, for instance, the case at the University of Minnesota, where every student pays (implicitly) a tax to ride on the campus transitway, and the University subsidizes the rest of the costs from other fees. The only people using the transitway

⁵⁶ (Lo 2018).

are students, faculty, staff, and others doing business or research at the University.

- Sometimes we give away transit in a business park. The punningly named Emery-Go-Round in Emeryville, California, functionally a business park with a few residents, is a circulator bus connecting to the MacArthur BART station. This is an amenity for tenants, and is paid for by a local Transport Management Association.
- Sometimes we give away transit in small cities. One of the largest US cities with free transit is Vero Beach, Florida, with a metropolitan population of 130,000 (though municipal population of only 15,000) which is largely a tourist town. In Tempe, Arizona, the city augments regional transit service with a fare free circulator bus that is paid through a sales tax. The largest city in the world offering free transit is Tallinn, Estonia, at 420,000 people (the metro area is only slightly larger at 543,000 people), which has only done so following a 2012 referendum.⁵⁷ Yet Tallinn charges for tickets for non-residents. In short, Tallinn residents are part of a largish club. The community (Tallinn) identifies the riders as ‘us’ rather than ‘them.’

⁵⁷ (Cats et al. 2014; 2017).

We could get into the causality of divisions into ‘us’ and ‘them,’ but we believe this is inherent in human nature:⁵⁸

When individuals having no established relationships are brought together to interact in group activities with common goals, they produce a group structure with hierarchical statuses and roles within it.

If two in-groups thus formed are brought into a functional relationship under conditions of competition and group frustration, attitudes and appropriate hostile actions in relation to the out-group and its members will arise and will be standardized and shared in varying degrees by group members.

⁵⁸ See the example from Muzafer Sherif’s 1954 Robbers Cave study of fifth grade boys in Oklahoma (Sherif 2010).

So can buses (or if need be, trains) be the source of uniting the community rather than a reflection of its divisions? The evidence of casual empiricism suggests large communities inherently fracture (red states vs. blue states) unless brought together under crisis (war, tornado, etc.). The problems solved by transit (road congestion, transport for the carless, emissions, the high cost of downtown and University parking) do not seem a strong enough glue to overcome this.

What would be the effect on a transit agency if fares went to zero? Elasticities don’t necessarily hold constant over large ranges, but a 100% reduction in fares at a -0.4 elasticity implies a 40% increase in riders. In most US markets, this is too high.⁵⁹ However,

⁵⁹ And while the evidence is mixed, Baum estimated -0.1 elasticity. (Baum 1973).

with about a 5% work mode share for transit in the Twin Cities now, this would increase transit work mode share to 7%. Assuming these new transit riders were drawn proportionally from the other existing modes this would reduce peak commuting auto mode share in the Twin Cities from something like 78.3% to about 77%. An improvement, but barely noticeable in terms of peak congestion, since some of that gain will be contracted due to peak spreading and [induced demand](#).⁶⁰

⁶⁰ §14.

The transit agency would need to make up the lost revenue or cut-back service (reducing costs to cover that lost farebox revenue) since its current 31% farebox recovery would go to 0%. Cutting service by 31% while raising ridership by 40% would about double average load factors (if done uniformly). When the bus is half empty, this is not a problem. In peak times this would lead to crushing loads. (Both the service cutbacks and the higher load factor would result in ridership rising by well less than 40% – induced demand works in reverse as well.)

Raising taxes for free transit seems politically difficult, though technically it would be quite simple to raise a tax on something else. For instance, a regressive sales tax on mostly non-transit users has been mooted by the business and transit advocacy community to subsidize transit.

Farelessness would make transit in the US more vulnerable to cutbacks, as it would not have its own revenue source and unless it were to gain massive ridership (and 7% work mode share does not count as massive) it would still not have the political buy-in for most people to see transit as serving ‘us’ rather than ‘them.’ The reason we have ‘free’ rather than tolled roads is that almost everyone identifies as a road user. To get the American driving public to see mass transit in the same light requires a major perception change.

Were transit free, very low value trips would get induced, for instance, teenage joy-riding, which would impose a negative externality on more serious riders.

When transit is on the left side of the [U-shaped average cost curve](#),⁶¹ with declining marginal costs, free can be argued as welfare improving. When transit has rising marginal costs (as in the peak, or full commuter buses perhaps), free is a less appropriate option.

⁶¹ §B.

Transit is a [private good](#),⁶² it is rivalrous in principle, and in practice during peak times, it is excludable. Further it can in many markets be competitive, at least in terms of competitive tendering for franchises, if not the full chaos of the market without property rights in stops, which even libertarians have identified as

⁶² §A.

City	(£- 2012)	City	(£- 2012)
Paris	1.44	Amsterdam	2.28
Toulouse	1.35	Rotterdam	2.28
Berlin	1.94	Stockholm	4.20
Munich	1.01	Göteborg	2.39
Rome	0.84	Oslo	3.39
Milan	1.27	Tokyo	1.25
Madrid	1.27	Osaka	1.56
Barcelona	1.69	New York City	1.41
Montreal	3.39		

Table 4.5: Global transit fares. Single price ticket in central zone. Source: (MVA Consultancy 2013).

problematic.⁶³ Funding at zero fares like a club good is plausible if you can clearly define an appropriate funding club (a small municipality, a business park, a university). Funding it at zero marginal fares when members pay a fixed seasonal or annual pass is more promising.

Higher fares should be accompanied by full cost pricing for competing transport modes – in other words, higher gas taxes or road tolls. Low-income users should get a direct subsidy from the public, not from the transit utility. This is akin to the universal service fund telephone utilities often offer.

COMPARISON OF FARES AROUND THE WORLD. Table 4.5 compares fares globally. The US has lower fares than elsewhere.

If poor riders were subsidized for some large fraction of the difference between current fares and the new fares, it could produce a farebox recovery rate of about 100% (depending on actual fare elasticities), compared to the 30-40% typical in US cities.

A perhaps more important point is that Canada has higher fares than the US, a higher farebox recovery rate than the US, better transit, and higher transit mode shares. What are they doing more right than the United States? We discuss this with the question of [federalism](#).⁶⁴

⁶³ (Klein et al. 1997).

⁶⁴ §17.3.

THE COMPETITIVE ENVIRONMENT FOR TRANSIT LIMITS HOW HIGH RATES CAN GO. In cities with a greater dependence on transit (and greater inconvenience for driving), transit agencies have more latitude to raise fares. The political environment also matters, and it may be simpler politically to subsidize rides for everyone, not just those who need it.

Lowering costs can also increase farebox recovery ratios, by lowering the denominator (expenses) instead of raising the numerator (revenue). As discussed elsewhere, [transport costs too](#)

⁶⁵ §9.1.

much,⁶⁵ so there are probably a number of possibilities for reducing expenses.

There are many policy alternatives for fares between \$4.50 and \$8.00 day, there is no magic number. Until transit is again privatized without subsidy there is no requirement for 100% fare recovery. It would almost certainly be a bad idea to do this kind of change overnight, large systems need transitions. Still, raising base fares should be on the table to give transit agencies more operational independence and to reframe their status from [whatever it is now] to what it once was and will eventually be again, a public utility providing a service in exchange for consideration.⁶⁶

Great cities have great transit and their users pay more for it.

⁶⁶ To be clear, as long as driving remains cheap there is little that can be done via subsidy to make transit more competitive. Drivers should pay the full cost of driving.

4.4 *Subsidize users not systems*

Even though there is broad agreement that transit should be subsidized, there is no agreement on how to subsidize or how much to subsidize. Consider capital and operating subsidy. These are related, but different enough that they should be addressed separately.

Capital subsidy can be direct or indirect (such as assistance with land acquisition), and these monies come from federal, state, metropolitan, local and sub-local sources. Traditionally capital subsidy has largely come from federal and state sources, though recently local sources have used sponsorship⁶⁷ and *value capture*.⁶⁸ Capital subsidy for transit expansion rarely, if ever, considers the effects capacity and network expansion have on operating subsidy, however. Since every transit system in the United States requires an operating subsidy, every service expansion increases the required operating subsidy and makes the financial position of transit agencies worse over the medium and long term. In the US, unlike many European countries, there is not even a requirement that benefit/cost analyses, projections, or planning consider what system expansion will do to operating budgets.

Operating subsidies are from local, regional and state sources. The federal government placed severe limits on using federal money for operations in the 1970s, in part because most of the increases in subsidy went to total wages without any increase in productivity.⁶⁹ The primary reason for operating subsidy for US systems now seems to be “that’s the way we do it here,” which is not a proper justification. Many of the cities around the world have much higher farebox recovery, fewer operating subsidies and much higher ridership than transit in the United States. Maryland for

⁶⁷ See the Emirates Airways gondola in London, for instance.

⁶⁸ See the 7 train extension to the West Side of Manhattan. The topic is discussed more in §16.

⁶⁹ (Pucher et al. 1983).

instance considered a 35% cost recovery requirement for transit.⁷⁰ This suggests a justification for less subsidy and higher fares: *planning without prices leads to bad planning.*

⁷⁰ (Shaver 2017).

THE CASE FOR SUBSIDY. For some public goods the case is obvious. In the absence of excludability and rivalry, one needs to get revenue from somewhere to operate a service that provides public benefits.

- Transit often operates on the left-hand side of the [U-shaped cost curve](#).⁷¹ Fixed costs are spread over more and more users as the quantity demanded increases, while marginal costs remain small if not zero. If we charge riders an average cost for a service with near zero marginal cost (which is an approximation of the situation in transit in the absence of crowding, certainly in terms of the short run marginal cost, ignoring a few things like the delays which boarding imposes on other passengers), we get under-consumption and under-supply compared to the social optimum. That means if we charge more than the marginal cost of the ride, we get a less than socially optimal number of passengers (there is a deadweight loss). Somebody who would ride at a lower price that was still at least as high as their marginal cost cannot. The social benefit (consumer's surplus) of that unmade trip is foregone. Unfortunately because of high fixed costs, this implies that fares at marginal cost will not recover total costs. Thus the natural monopoly / economies of scale or density / declining fixed cost is one aspect that might warrant subsidy.

⁷¹ §B.

- There are network externalities associated with public transit. The more users of transit there are on a system, the more useful the system is for [everyone](#).⁷²

⁷² §A.4.

- Transit helps the [transport disadvantaged](#).⁷³ This is part of the argument used for the creation of the Urban Mass Transport Act in 1964, the first federal program to provide assistance to public transport. Equity or welfare has often been an argument in favor of subsidy, that we do it to provide benefits for people unable to afford otherwise, or transport for the disadvantaged. This gets more into values than economics, but there are some people who would be employed but for their ability to access jobs, so some subsidy on the transport front is at least partially repaid by more economic productivity.

⁷³ §21.

- Transit subsidy helps poor jurisdictions. Spatial cross-subsidies help poor jurisdictions rather than poor people.

- Transit arguably reduces [congestion](#),⁷⁴ on other modes, by taking

⁷⁴ §5.

cars off the road, and therefore benefits drivers (who should thus pay for it).

⁷⁵ §11.20.

- Transit stimulates [economic development](#).⁷⁵
- Cars are subsidized, therefore transit should be subsidized.

These aspects argue in favor of subsidy. But then the questions arise: Subsidy from whom? Subsidy for what? What is the appropriate base for providing subsidy?

⁷⁶ §A.

Here we argue in favor of a [club good](#),⁷⁶ model. People in the Club should help subsidize the service.

The beneficiaries of transit are relatively local. If we live in Phoenix, the option of riding transit in Las Vegas or Curitiba is of essentially zero value. The option of riding transit within the greater metro area is of some value, and the option of riding transit in downtown is of high value. The option of riding transit that runs directly from home to the desired destination is the highest value. Benefits diminish with distance from the system.

We can define the Club more narrowly as anyone who might want to use transit and is willing to pay (or whose employer or university is willing to pay or help pay) for a season pass. One example of this is apartment building managers who supply their tenants with shuttle vans.⁷⁷ An advantage of using a season pass model (rather than pay per trip) is the ability that it presents in providing services without excessively under-pricing the transit service. Whoever wants to provide transport benefits for the transport disadvantaged can subsidize those whom they want without subsidizing everyone.

⁷⁷ For an example from Pittsburgh, see [\(Walnut Capital 2018\)](#).

We can define the Club a bit more broadly as landowners whose property value is increased by the presence of transit. The option of riding transit sometimes is public good (i.e. the option is neither rivalrous nor excludable), and its value is embedded in locations near transit stations. This appears to justify some form of value capture approach (of which property tax is the most widely used, but certainly not the most direct or efficient mechanism).

Both of these clubs are smaller than the municipalities in which transit operates, and much smaller than higher levels of government, like county, state, or nation.

THE CASE AGAINST SUBSIDY. Though there are clearly some arguments in favor, we promised arguments against transit subsidy as well.

- Transit is basically a private good. Private goods can be privately provided, which aligns incentives of the producer with their

revenue model directly, better performance is rewarded, worse performance is punished. When all transit lines – and road networks for that matter – are planned and operated below cost we simply don't have any idea what the true value of any service is. This is true whether publicly or privately supplied. As we write this, large amounts of venture capital are subsidizing travel through Uber, Lyft, Didi, Bridj, Chariot and others – and we simply don't know what actual demand is where the firms can be profitable. We suspect they do not either. If fares increase to cover costs, or at least come closer to covering costs, service can adapt to revealed demand and firms and households can adapt accordingly. Without proper prices we don't know where to increase capacity or improve service. We can't identify actual bottlenecks or spread peak demand across more hours in the day by using dynamic pricing. By planning service while blind to the value of the service, everybody is a bit worse off and many actual transit riders are substantially worse off.

- The network effects might be relatively small either because they are already played out (high frequency service in a high density city), or because they never will be (low frequency service in a low density city). The best opportunity is thus low frequency service in a high density city, in which service can be increased. Downscaling may need to occur in places with high frequency and low density. Many technologies have network effects but don't require public subsidy. From Facebook to your ATM networks the amount of public subsidy is zero, or small. What is usually required is a monopoly (AT&T of yore, airline hubs), some type of lock-in (social networks), collusion (credit cards), or cooperation (the English Language), which readers of this book all use without the government subsidizing.
- Though there are always returns to density (more riders on the bus always lowers the cost per passenger on the bus), bus systems have approximately constant returns to scale (more buses are not less expensive per bus than fewer buses). Many places have figured out an economic model which does work from a profitability stance. There is little reason economically to run a service with many buses under the auspices of a single monopolistic organization. Constant returns industries don't warrant the same subsidy as increasing returns industries.
- While it is claimed transit should be subsidized to stimulate economic development, it is also claimed that economic

⁷⁸ §11.20.

development should be subsidized because it stimulates transit. It is not clear which, if either, or both, are [driving this cart](#).⁷⁸

- Fixed route transit may be made obsolete by new technologies, especially outside of cities and in off-peak periods.
- One bad subsidy does not deserve another. Just because cars are subsidized is not a reason to subsidize transit. It is an argument to remove the subsidies that exist. Technically (if not politically) it would be relatively easy to charge cars for their full cost (i.e. eliminate their subsidy) via higher fuel taxes (or mileage fees) but the amount of the incremental charge would have a very small effect on total automobile use.

⁷⁹ §A.4.

- As for the [Mohring effect](#),⁷⁹ how much should a transit rider pay for the bus or train not taken (subsidy for options)? Consider a downtown worker who prefers to take transit to work, but sometimes has to work late into the evening. There is lots of service for typical 9-5 employment, but a major reason workers are comfortable on transit is that they know there is adequate service for occasional trips such as when they work late. Let's say that a optimal fare that covers direct costs for a rush hour bus is \$2, but every other week a worker has to stay until 9:00 pm when service is infrequent. Should the regular fare be \$2.20 to reflect the required subsidy for the not-full 9:00 pm bus? Or should occasional trips be shifted to taxis or made the employers' problem? In Manhattan most corporate employers will pay for a taxicab home for employees who work past 9:00 pm, and San Francisco employees are more likely to ride transit to work if they know that they can take a cab for their return trip.⁸⁰ As this is off-peak time for taxicabs perhaps this is a more optimal solution than subsidizing increased fixed-route services.

⁸⁰ (Hara and Canapary 2013).

- Finally there are many reasons not to trust the recent experience in transport with investment. The costs are too high and the benefits are too low. Giving more funds to existing institutions to build more capital-intensive infrastructure while existing infrastructure deteriorates may not produce the hoped for results.

4.5 *Refactoring subsidies*

There are poor people, and society won't give them enough money directly, (demand-side subsidies). Should society then subsidize services for them (i.e. provide supply-side subsidies to the public sector)?⁸¹ Clearly that is what the US does. But what should the US do for the poor?

⁸¹ See (Freemark 2011) making the case for spatial subsidies.

The public should subsidize transport for the disadvantaged from non-transport specific revenue sources. Perhaps the biggest problem with current subsidies is that they are place-based and not people-based. Why should the entire system be subsidized? Also, why should a professor pay the same fare as students? Or in New York, why should former Mayor Bloomberg, the richest guy in the city, pay the same fare as the cleaning staff of Bloomberg, Inc.?

DEMAND-SIDE SOLUTION: GIVE THEM MONEY. The greatest consequence of an effective fare increase to cover 100% of operating costs would be on the poor. One strategy (which appeals to libertarian and rationalist sensibilities) for dealing with this problem is the negative income tax (endorsed by both Milton Friedman and the US Green Party), i.e. give the poor money to spend as they choose.⁸² There are some public policies which do this (Earned Income Tax Credit), and others which have been proposed (Universal Basic Income) but nothing so blatant as systematic cash handouts. It is a clean elegant solution that avoids distortions. Hence politicians don't like it.

⁸² (Friedman 2013).

One of the concerns is with incentives. If we just gave people money for being poor, wouldn't we get more poor people? The other concern often raised is one of financial responsibility. Some people are poor temporarily due to bad luck or circumstance. Others have trouble with financial management – just giving money would not help.

DEMAND-SIDE SOLUTION: TRANSPORT CHOICE - GIVE THEM TRANSPORT VOUCHERS. If policy-makers don't trust the poor with money, and this seems to be the attitude of American society, which does not actually give much money directly to poor people, give transport vouchers to the poor to spend on transport as they choose.

Policymakers should transform today's system of mass-transit subsidies into an individual transport-choice program directed to meeting the needs of consumers rather than producers, by providing transport vouchers to America's neediest. Low-income people would be issued accounts and smartcards giving them access to a set benefit that could be used for any eligible public or private transport service (including transit fares and passes, taxi rides, gasoline, tolls, car purchases, and car repairs).

We propose that this replace the bulk of the Federal Transit Administration's program grants for specific capital investments, which would be defunded. States, metro areas, and localities that wanted to invest in new transit infrastructure could still do so, but

would make choices that were locally worthwhile given their own situations, rather than decisions based on the premise that someone else will pick up half the bill. Existing mechanisms like user fees, land value capture, taxes, bonds, or non-forgivable loans from state (or perhaps federal) infrastructure banks remain as ways to fund and finance such investments.

This proposal would provide help to a broader base of low-income families, not just those fortunate enough to live along new transit lines. Instead of assuming what types of transport people should use, it would give people a choice of how to spend transport dollars in a way that best suits their own lives. Many travelers will choose transit, paying for the services they use. But transit is not the best choice for all (or even most) low-income workers, so why should transit infrastructure be subsidized on equity grounds?

Rather than subsidizing all travelers with low fares, transit operators could be permitted to raise fares as necessary with fewer concerns about equity, since low-income travelers would have vouchers specifically for that purpose. The share of operating costs paid by fares should increase from the current average of 33%. Because the stream of revenue would be higher, cost-effective projects would be more likely to break-even operationally and repay capital costs over time, and thus could be justified as investments.

The risk is that the poor with the transport voucher might find [buying a car or gasoline](#)⁸³ is a better decision than riding transit, especially if their jobs and homes don't align with the network. While this is presumably better for the individual traveler (why would they allocate their resources that way if it weren't), it doesn't help the transit agency or other travelers, as it weakens transit service by removing the positive externality they would otherwise generate, and adds to congestion on roads in the short run.

⁸³ §21.

DEMAND-SIDE SOLUTION: GIVE THEM PUBLIC TRANSIT VOUCHERS. And if transport vouchers are unacceptable, public transit-only vouchers are also straight-forward, and better for the transit agency itself. This could be administered by topping up a recipient's per use transit pass with \$X per week, or giving a monthly pass, or some other mechanism. Recipients of top-ups would use the same smartcard as everyone else, so no public stigma is attached to using the card. Moving towards smartcard systems is efficient all around, saving boarding times and reducing transit run times. It could also be administered when anyone qualifies for other social services, such as unemployment insurance or food assistance. If people have trouble eating they probably have trouble with the

expense of travel. For instance, the city of Seattle pays the transit agency \$3.8 million per year in order to provide free transit passes for all public high school students.⁸⁴ It accomplishes the appropriate ends, without burdening the transit system with this welfare function. It also allows freedom for funds to be spent on taxi or rental car as needed (if in cash-equivalent form), rather than just fixed-route transit.⁸⁵ Just because some people are poor does not mean they don't have other transport needs.

⁸⁴ (Gutman 2018).

⁸⁵ (King 2009).

Presently, the 'budget' for subsidies for the poor comes from the transit agency. Instead the budget for negative income tax, transport vouchers, or transit vouchers should come from general revenue, as the primary objective is to help individual people, not transit systems. These funds would be billed to a separate government agency (let's call it the 'Transport Opportunities Office') which is completely separate from the transit organization.

WHO SHOULD PAY FOR SOCIAL FARES? King County Metro, in Washington, announced a low-income fare policy in 2015. This is from the King County press release:⁸⁶

⁸⁶ (King County Executive Dow Constantine 2014).

"Rising housing costs are leading many families to locate in lower-cost locations that may be farther away from where they work," said Mike Heinisch, executive director of South King Council of Human Services. "Providing a low-income fare is one way we can help keep the region more affordable for working families and ensure equal access to economic opportunity."

"As a social service agency, we work with people who are in dire need of affordable public transport to get to training classes, meet with case managers, find and get to jobs and health care appointments, as well as other important appointments," said Mahnaz Kourourian Eshetu, executive director of Refugee Women's Alliance. "The efforts of our County Executive and County staff to make the discounted transit fare widely available to people who need it the most is admirable and will have a positive effect on the County's economy while creating stronger communities. It was an honor to serve on this task force."

"King County is one of the first regions in the nation to put a low-income fare in place, helping to make sure that our bus service really is serving the whole community," said Alison Eisinger, director of Seattle-King County Coalition on Homelessness. "We can be very proud that we are putting our values into practice in this way, by taking a big step that will help advance greater equity and access to opportunity. Thousands of people, and our community as a whole, will benefit from this progressive policy."

While laudable, why is it the transit agency's responsibility to pay the \$8 million or so annually? So Human Services, the Refugee Women's Alliance, and the Coalition on Homelessness are all part

of a coalition supporting low fares for certain groups. While we agree that all of these groups deserve affordable travel, we don't see why these benefits should be paid directly from the transit budget. Expecting the transit provider to also provide social services is not sustainable unless someone directly pays for those social services. The public has a social obligation to provide access to opportunities, but this doesn't mean the mass transit operators should pay for social programs.

DON'T SUBSIDIZE EVERYBODY. Only as a last resort should we distort an entire transport mode and drive it into perpetual 'crisis' mode for the sake of subsidizing a subset of users. This worst solution is to subsidize transit for all riders. This needlessly reduces the resources available to operate the transit system, and keeps transit agencies in the subservient position of having to beg for money on a regular basis rather than being fully funded by their users.

SUPPLY-SIDE SOLUTIONS: BUILD THEM STUFF, RUN THEM LINES. If politically it is too hard to actually help the poor directly with demand side subsidies, which might pull through new investments, we can push service and subsidize that spatially. Clearly it is less efficient, and likely winds up benefitting the wealthy at least as much as the poor. To use this last resort is basically the problem of the first best and second best.⁸⁷ In the first best world, we act as if everything else is also optimized, in the second best, we optimize given the suboptimality of the rest of the world. But by doing so, we consign the rest of the world to suboptimality as well.

Just as roads are underfunded and we see congestion, because they are not priced properly and spending is too focused on expansion rather than preservation, a point that is made elsewhere in this book, transit is underfunded and we see both crowding in some places and literally, (yes literally) empty buses in others, both of which are the consequence of severe misallocation of resources to achieve the what Jarrett Walker calls 'coverage' aims.⁸⁸

Places that would see service dropped once you went to an appropriate funding model are not the poor inner-city areas, which are (or ought to be with appropriate management, regulation, etc.) profitable given their relatively high densities, but instead the low density suburban routes. (Recognizing that the poor are suburbanizing in many metropolitan areas). The current model is largely a cross-subsidy from the poorer areas to the middle-class areas.

⁸⁷ See: (Lipsey and Lancaster 1956).

⁸⁸ (Walker 2012).

UCLA transport planning professor Brian Taylor writes:⁸⁹

⁸⁹ (Taylor 1991).

Federal subsidies of public transit, particularly transit operations, are declining and the responsibility for supporting transit is falling increasingly on states and localities. In California, the Transport Development Act (TDA) has become the state's principal source of transit operating subsidies. It is found that the strict per capita allocation formulas of the TDA strongly favor lightly patronized suburban transit service over more heavily patronized service in the central cities. Transit riders in San Francisco, for example, receive a TDA subsidy of \$0.13 per trip, whereas the TDA subsidy to transit patrons in suburban Livermore is over \$5.00 per trip. The built-in suburban bias of the TDA is the result of partisan compromises made to secure passage of the Act in 1971 – compromises to assuage a Republican governor opposed to new taxes – and to include the interests of rural and suburban counties. The result has been a proliferation in California of new, well-funded, and expanding suburban transit operators that attract few riders whereas older, heavily patronized central city transit operators are forced to cut service because of funding shortfalls.

While the numbers have changed since he wrote that, the basic observation stands.

5

The Solution to Congestion



Figure 5.1: Congestion due to taxis in New York City at Penn Station. Photo by D. Levinson.

In many ways, congestion is the reciprocal of mobility, the ease of movement on the network. Congestion occurs when a facility is overcrowded. So if a bridge can carry 3,600 people an hour,¹ but at 7:00 am 4,000 people want to use it,² we say it is congested. At the end of the hour, there will be 400 people left waiting to use the bridge, who will presumably be first in line to use it during the next hour.³ Congestion can occur on all modes, since every mode has a capacity, and on any facility, which again have some capacity.

In practice, many modes operate very far from capacity, have excess, unused, or spare capacity, and thus don't see congestion with additional users. Congestion matters to users because of the delay that results,⁴ the travel time above and beyond what the user would have experienced in its absence.

Congestion is bad. In economic terms it is a deadweight loss. If we could organize everyone better, we could have travel without

¹ Its capacity is given by ($Q_{bridge, capacity} = 3,600$).

² Its demand is given by ($Q_{bridge, 0700} = 4,000$).

³ This is a first-come, first-serve process, and applies to many queues.

⁴ Congestion can also add to travel time uncertainty, which is another cost to users.

⁵ The basic equation for travel by automobile is given by:

$$v = t \cdot d \cdot s \quad (5.1)$$

where:

- v = vehicle kilometers traveled,
- t = total number of trips,
- d = average trip length (km),
- s = share of trips by auto.

If there were fewer travelers, or they used their cars less, or they traveled shorter distances there would be less travel.

We can measure flow ($q_{n,h}$) in network area (a road segment, a bridge, a neighborhood, a city) (n) per hour (h).

$$q_{n,h} = t_{n,h} \cdot s_{n,h} \quad (5.2)$$

If the travelers traveled at times when there were fewer other travelers, there would be less congestion.

The basic equation for delay due to congestion (x) is

$$x = f \left(\frac{q_{n,h}}{q_{n,0}} \right) \quad (5.3)$$

where:

- h = index of hours,
- k = index of network areas,
- $q_{n,h}$ = flow on network area (n) per hour (h),
- $q_{n,0}$ = hourly capacity on network area (n),
- x = delay due to congestion.

congestion, some people would just wait longer at home or work before departing, to avoid queueing.⁵

Reducing travel is largely a behavioral change, though it is affected by the distribution of activities and by the structure of the network, increasing capacity requires investment or technological shifts.

5.1 Welcome to the club

So your city has traffic congestion.

Welcome to the club. Congestion not only wastes time, it increases pollution and crashes. While this undoubtedly annoys you as a traveler, it could be worse; your city might not have congestion because no one wants to be there. Still, it would be great to have a thriving city without congestion. People could reach more destinations in less travel time, and thus have more time to spend doing the things they wanted.

Political double-speak today ‘addresses congestion’ rather than ‘solves congestion’ (almost twice as often according to Google). This is probably because policy-makers want to sound like they are doing something without promising anything. But talking to congestion doesn’t accomplish much.

There are a number of proffered solutions out there. Congestion is, in principle, a mostly solvable problem, even if no fast-growing city has fully solved it. This chapter outlines many ways that congestion could be solved. Some of these are dumb, many are good, one is great.

5.2 Supply-side solutions

The first set of strategies are basically supply side.

CAPACITY. Perhaps the most obvious, ‘common sense,’ solution when demand (traffic) is in excess of supply is to expand capacity. This is what we do with most things if we can. In roads, this usually means adding lanes to existing roads.

The first problem with this solution is that it is expensive. In many places where you want capacity, existing buildings are built close to (or on) the proposed expanded right-of-way, so taking them in addition to being costly brings in an additional socio-political dynamic – people don’t like to be moved.

Unfortunately, there are rising costs (and diminishing returns) to capacity investments. All the high benefit, low cost projects have

already been done. Lack of space in built areas means to add capacity cities look to build elevated or tunneled roads (since all the good surface rights-of-way are already used). This is extremely expensive (look at Seattle's Alaskan Way or Boston's Big Dig or Sydney's WestConnex).⁶ Perhaps there will be technological breakthroughs which reduce the costs of tunneling, or other construction. It hasn't happened yet.

Further, if you expand capacity, [demand](#)⁷ will respond. While population isn't growing rapidly in the developed countries, travelers will switch routes, time-of-day, mode, and destination to take advantage of the new faster travel times, which means these wider roads won't be nearly as much faster as hoped for. New (induced) developments will be built, and much of the capacity will quickly be used up by new travelers. There will still likely be a small amount of travel time saved for existing travelers, and the new travelers do gain benefits (otherwise why would they make the trip), so it is not necessarily a bad thing, but it may not solve your congestion problem.

CONNECTIVITY. Often the problem is not width of the road, but where it goes. A new road that goes directly to the right place can replace a longer route that doesn't. So reducing the circuitry (indirectness) of the network through selected connections can reduce congestion and total traffic by taking traffic off of longer routes. Even when there is nominal connectivity, it might not be very good. A bridge can replace much slower and lower capacity ferries, eliminating a bottleneck. But as with capacity expansions above, it can be very expensive. In a mature network, all the cheap and useful roads have been built already. A new connection may be cheap, or it may be useful, but it won't be both. The induced demand outcome also applies, and improved connectivity will increase travel.

CLOSURE. Perhaps counter-intuitively, if we shut down key links on the network, we could also reduce congestion. If people can't get across the River, they won't drive from home to the River either, reducing traffic along that path. Just as there is induced demand when capacity is added, there is reduced demand when it is taken away, as after the I-35W Mississippi River Bridge collapse.⁸

In selected cases there is something called Braess' Paradox,⁹ which says that some links result in an increase in overall travel time when they are added (and so reduce overall travel time when they are

⁶The Big Dig came out at \$US14.6 billion. The Alaskan Way Viaduct replacement tunnel has been estimated at \$US3.3 billion. WestConnex is expected to cost \$AU18.6 billion.

⁷[§14](#).

⁸([Zhu et al. 2010](#)).

⁹See ([Braess et al. 2005](#); [Murchland 1970](#); [Pas and Principio 1997](#); [Rapoport et al. 2009](#); [Steinberg and Zangwill 1983](#)).

closed) because individual selfish routing choices can lead to bad outcomes.

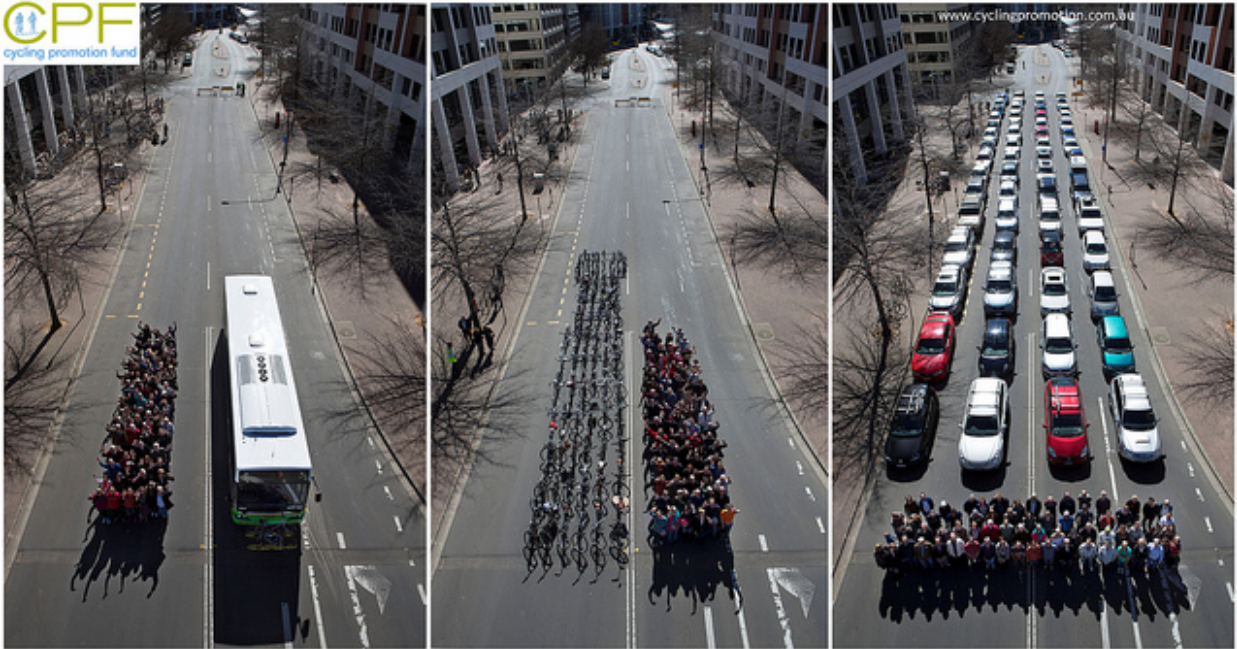
One solution for reducing traffic congestion that is seldom discussed is banning the car, at least in places, which undoubtedly reduces traffic congestion locally. Many city centers in Europe are banning the private car. So, there are now and will be more places that are free of traffic.

CONTROLS. The next most obvious solution is to use the infrastructure we have better. When we have a stop sign controlled intersection, and there are long queues, we add traffic lights, which manage traffic better because there is less time lost in starting and stopping. Coordinating traffic lights on a city street grid can make sure more vehicles hit green lights in sequence. The use of controls (also called capacity management) on freeways includes devices like ramp meters, the traffic lights at freeway on-ramps, that manage the input flow to keep the freeway flowing (more) freely (than it otherwise would). Traffic engineers have suites of controls that manage traffic flow and squeeze in a few more cars on the same set of pavement by reducing the size of gaps between vehicles. These can help. These all may be worthwhile. However, this is on the order of a 10% reduction in congestion, rather than the 100% we would like to see. And these gains are potentially absorbed by both general traffic growth where that occurs, and induced demand in a mature system.

¹⁰ §7.7.

¹¹ (Vanderbilt 2008).

CRASHES. It is sometimes estimated that half of all delay is due to non-recurring congestion, most notably [crashes](#).¹⁰ First, we want people not to crash. Crashes can be reduced by better designed roads, such as greater separation of vehicles, slower speeds or, in some cases, increasing the mix of traffic as suggested by Hans Monderman.¹¹ Crashes can also be reduced with better-trained drivers. Making licensure more difficult so the drivers are better is one strategy. Making driving more expensive so fewer people (and especially fewer marginal drivers) are driving is also significant. More importantly, crashes can be reduced by better-designed drivers. Over the longer term, we need to replace the human with the machine. Second, we want crashes to be cleared quickly. Quick emergency response helps save injured travelers. Freeway service patrols (under various names) help clear crashes and reduce the amount of subsequent delay.



CONSTRUCTION. Maintaining roads is important, without proper maintenance they would eventually cease to be. But closing entire roads for construction can't be the right strategy, can it? Well, it depends. The alternative, trying to do construction one lane at a time will take much longer. So for a four lane road, closing one lane at a time for six months each will take two years, but closing all four lanes, and requiring travelers to detour might take less than six months as it is more efficient.¹² Doing all work at night or weekends is another strategy. The cost of the delays vs. the cost of construction need to be properly weighed.

COMPETING MODES. Just as widening a road is in theory a solution to a congestion problem, building a competing mode is also a theoretical solution. By building a rapid transit line or running an express bus, or even building sidewalks and bike lanes, other people may switch off the road, leaving the roads faster for the rest of us. The traditional induced demand argument follows. The evidence on this is weak though, most transit construction serves transit riders (which is a good thing) and doesn't reduce congestion much.

GAUGE. Track gauge, the width of railroad tracks, determines the width of the trains. As with railroads, the gauge of roads has been largely determined, with freeway lanes being 3.65 m wide,¹³ and

Figure 5.2: Recreation of famous Munster image. Road space: bus vs. bikes vs. cars. Photo by Canberra Cycling Promotion Fund. (Bowen 2012).

¹² (Hourdos and Hong 2010).

¹³ 12 ft.

cars, buses, and trucks are narrower so that they fit. Lanes on surface streets vary a bit more, but tend to be similarly sized in newer developments. Most cars carry one person most of the time, but are sized for at least four, two in parallel, and two rows. If cars were half as wide, we could fit twice as many in the same space. This is what we do with motorcycles and bicycles. Pedestrians can even fit more, as shown in Figure 5.2. Before the motorcar, long distance travel by horse was one man / one horse usually, and the occasional horse and carriage for multi-person trips or cargo. Now the carriage is brought along whether it is needed or not, wasting space and delaying others. Redefining the gauge of road lanes, so that lanes at least are split for narrower cars could double capacity.

STORAGE. On surface streets, we waste pavement storing parked cars, usually for free. A lane or turn-lane or half-lane or bike-lane or bus-lane can often be added in the space devoted to unmoving metal, increasing throughput. Adjacent property owners are often under the mistaken impression they or their customers have a right to park (for free!) on the public street in front of their house. When there is no congestion, this is not a problem. Where there is congestion, [this artificial right](#)¹⁴ is costly to society.

¹⁴ §4.1.

LAND DEVELOPMENT. Land development, regulated or not by land use planning, can increase accessibility, it can make cities more valuable, and it can increase transit ridership, and in selected cases, can reduce traffic.

Balancing housing and jobs, so that they are located near each other, logically reduces travel compared to a situation where those same jobs are far apart. This has long been understood in the transport planning community,¹⁵ but is not well grasped among the general public.

¹⁵ (Cervero 1989; Levinson 1998).

However, moving a fixed number of things around is not how cities actually grow. Telling place *A* you taking away their employment is controversial. More generally new things are added.

It is commonly asserted that more development adds to congestion. And often this is true. But not always, it depends on the type of development. More housing in a housing-rich and job-poor area will result in more total travel. More employment in a job-rich, housing poor area will do similarly. More housing in a job-rich area, and more jobs in a housing-rich area can actually reduce travel.

There are also marginal things about where you locate driveways and such, but the main issue is that development density, which is good for transit, will increase rather than decrease the number of

people in any give space and thus congestion in its vicinity. Each additional traveler has a non-zero likelihood of using a car, adding to traffic congestion. Even if travelers don't own their cars, evidence to date suggests that ridehailing, such as Uber, adds substantially to congestion in dense cities where auto ownership is low.¹⁶

¹⁶ (Schaller 2018).

Allowing or encouraging mixed uses will reduce some need for some travel, as people can do multiple things on-site, and reduce trip lengths, but the basic laws of travel demand are that more people, jobs, shops, restaurants, will generate more traffic locally than fewer people. It is also the case that as trip distances and costs decrease, people will travel more often. In a place like Manhattan, people frequently walk to the grocery store daily, while in suburban Phoenix, a weekly or fortnightly trip to stock up at Costco is more common.

On the plus side, increased density can help reduce exposure to congestion. Since places to go are closer together in denser cities, travelers might spend the trip in congested conditions but the overall time spent traveling is lower than for spreadout areas. If congestion is measured as increased time delay per unit of distance traveled, by reducing the distance traveled overall delay and congestion will decline.¹⁷

¹⁷ Joe Cortwright at *City Observatory* developed this idea more fully (Cortwright 2014).

5.3 *Demand-side solutions*

But congestion is caused by a mismatch of supply and demand, so the remaining strategies focus on demand.

This first set of solutions addresses supply, the capacity side of the equation. The second set of solutions address demand.

LOCATING. Putting land use into a pattern that makes it easy to travel is a supply-side strategy to reduce congestion. The demand side analog is choosing to locate conveniently. If only other people lived near where they worked (shopped, studied), they wouldn't have to travel as far, and so would be on the roads less (assuming they still traveled by car) or not at all (if they walked). While at some level, people coordinate location of origin and destination (they are usually in the same metropolitan area), they could certainly do so better. From a public policy perspective, moving more jobs close to where people live, and more people to where the jobs are, increasing the local balance between jobs and housing can reduce travel. In practice this is difficult, as there is no mechanism to require people to take local jobs or firms to employ local residents. The best municipalities can do is implement **zoning**¹⁸

¹⁸ §13.

that permits developers to build appropriate developments.

Still, ensuring the opportunities are there is one thing (and at best you can ensure developers are permitted to develop these opportunities), ensuring people partake of those opportunities is another. The cost of this also needs to be considered. There are reasons many firms like to locate near other firms rather than workers, which has to do with economies of agglomeration and the efficiencies that can be had from close [inter-firm coordination](#).¹⁹

¹⁹ §12.

TELEPRESENCE. At the extreme of mutually co-locating home with respect to work is working at home. This involves no commuting travel outside the home, though may induce some additional non-work travel outside the peak. This has been growing slowly over the past decades, and is amenable for many, but by no means most, jobs. Like location, this is largely an individual decision. Better broadband would help, and encouraging employers to allow or require employees to work from home would not reduce this trend, but it is hard to see outside of money or regulation in some form what persuades firms to behave differently with regards to incentives for where employees work. Still, the more people that tele-commute (tele-shop, etc.) the fewer that are traveling, all else equal, which it never is.

INFORMATION. People are terribly inefficient routers, choosing routes that are not only not the shortest for society (which is to be expected) but not the shortest for themselves either.²⁰ Using real-time traveler information rather than their own intuition and incomplete mental maps, drivers can find the shortest path to their destination, reducing their trip length and travel time, and reducing congestion for others. This comes at a cost, however, as research suggests that real-time mapping has diminished our cognitive maps and ability to navigate cities without aid.²¹

²⁰ (Zhu and Levinson 2015; Tang and Levinson 2018).

²¹ (Neyfakh 2013).

AUTONOMY. If we can get the driver out of the loop, so cars can drive themselves, we could narrow lanes (and thus get more of them per unit of pavement) and cars could follow more closely. While humans can barely safely drive with a two-second following distance between vehicles, autonomous vehicles with advanced sensors, in an environment where most or all the cars are autonomous, are expected to follow at less than one second. That doubles capacity. Automated vehicles also don't require nearly as wide a lane as human drivers do, which could almost double capacity again (this is the same gain we would see with narrow

cars).²² How well this works on city streets, as opposed to freeways, remains to be seen, but up to a four-fold increase in freeway vehicle capacity just from a fleet of fully automated vehicles is well-within the realm of possibility, and while it will induce demand, should buy significant congestion reduction gains. Even non-freeways will benefit as more travelers switch to the less congested freeways.

²² There are a host of regulatory and consumer preference changes that have to occur for this scenario to pan out.

SCHEDULING. We also wouldn't have congestion if not so many people wanted to travel at the same time. We could stagger work hours, so not everyone arrived at work at the same time. Some large firms already do this, but it could be expanded. The downside is that the whole point of everyone going to work at the same time is that they be there together (or at the same time as customers and vendors) so that can collaborate. The point of going to work is only in part the ability to use expensive machinery in isolation. It is also about the gains from cooperation of people being at the same place at the same time. If people didn't need to do that, and were (almost) as efficient as working from home, then there would be little point in traveling to work at all.

SEQUENCING. We do not begin and end all trips at home, we chain our trips together to reduce the total amount of travel. We go from work to the store to another store to home. This not only saves us time, it reduces congestion. Do this more systematically, with a little more planning, and you can reduce more congestion. Trip chaining as described here is one reason that the evening rush hour commute covers more hours than the morning rush, as people combine their drive home with errands and activities to minimize total travel.

SHIPPING. Just as chaining trips may be efficient for you, chaining trips may be good for your goods. Instead of you and your neighbor each making a trip to the store and back ($A \rightarrow \text{Store} \rightarrow A$, $B \rightarrow \text{Store} \rightarrow B$). The store can send out a truck (or robot, or drone) and drop off goods at you and your neighbor's houses before returning ($\text{Store} \rightarrow A \rightarrow B \rightarrow \text{Store}$), which should reduce the total mileage on the network (though the trucks will need to load and unload frequently).

SHARING. Carpooling has been around since the dawn of cars, and sharing the back of a horse, camel, or llama before that. It is easiest when there are two people going from the same place to the same place (like members of the same family going from home to work) at the same time. All this sameness though requires coordination to arrange, or sophisticated matching to discover. While people may

carpool with non-co-resident coworkers in their youth, one party (whoever is the most efficient or earliest riser) will tend to find the cost of waiting for the ride (or worse, waiting for the passenger) to be too costly, and eventually everyone gets their own set of wheels if they can afford it. HOV lanes or restrictions in some cities encourage people to pickup strangers (sluggers or jockeys) to fill up the extra seats to save time.²³ Overall this is a small phenomenon, though many firms and futurists expect carpooling to make a comeback through shared robo-taxis. But imagine you could get paid for picking someone up along the way and dropping them off – ridehailing services like LyftLine and UberPool are moving in this direction – you might be more inclined. Information technology is enabling everyone to be a taxi-driver. Whether everyone wants to be one is another question.

²³ (Burris and Winn 2006).

²⁴ In the Phoenix region, for instance, Valley Metro offers a vanpool program. Originally the program was a response to non-compliance of air quality according to the EPA, but there are over 430 commuter vans in service. Any group of at least six people in the region is eligible to receive a van from Valley Metro, and is responsible for gas, maintenance and insurance of the vehicle. The advantage is savings on parking and access to the HOV lanes.

²⁵ The difference between this and competing modes above is that this sharing with scale emerged organically, while the other is a top-down investment in fixed route transit lines – process matters.

²⁶ In 2018 NBA star LeBron James opened a new public school in his hometown of Akron, Ohio. The school is for at-risk kids and offers many unique services, including extended hours, job-seeking assistance for parents, all meals for the kids, college scholarships, and a bicycle for every student. James believes that bicycles offer freedom for kids to explore their communities (Elkins 2018).

SHARING WITH SCALE. Suppose instead of picking up one person, you picked up two, or four, or eight, or sixteen, or thirty-two. You became a jitney or vanpool or even a bus-driver. And if you pick up a lot of people, maybe that is more remunerative than the job you have, so you become a professional. And if you picked up thirty-two people along the way, you would want to be careful about the route so you don't delay the passengers on board (your paying customers) too much. You have discovered the continuity between driving alone and public transit. And if someone else is driving a nice vehicle on a convenient route, maybe you forego the car and ride instead.²⁴ You have helped reduce congestion. And if one vehicle is carrying thirty-two people who otherwise would have driven, we have removed thirty-one vehicles from the road. And if everyone were in a vehicle carrying thirty-two people, we can reduce congestion almost 97%. But for all the reasons identified above, this magnitude is unlikely.²⁵

WALKING OR BIKING. Maybe you still like your independence and don't want to comport to someone else's schedule, you just don't want to be in a car. If more people walked instead of driving, the sidewalk utilization rate would increase, while the road utilization rate would decrease. Bikes similarly would congest bike lanes and bike paths, but that's not as much of a concern, and bikes in mixed traffic can sneak through without congesting cars that much. Walking and biking are both up over the past decade. The best opportunities for substitution are for short distances, which are a large share of trips though a much smaller share of miles.

For \$30B or so, we could buy everyone in the United States a bicycle. For \$6 billion, we could buy every kid in the US a bicycle.²⁶

To gain some perspective, this is a lot less than the cost of our present vehicle fleet or major infrastructure investments, and \$30B is less than the cost of rebuilding all the NFL stadiums in the US, which we collectively do every 25 years anyway. What kind of changes would we see if bicycles were more ubiquitous? Would people ride more? Would they drive less? Would they demand different infrastructure? Would health actually improve?

As of this writing we are in somewhat of a natural experiment about cycling. There is a global push for new bike and scooter sharing systems. Many firms are supported by piles of cash from venture capitalists to put as many shared bikes and scooters on the streets as possible. A new twist is that many of the vehicles are now electric, which makes biking much easier. As mentioned elsewhere, we don't know where these technologies will be in the years ahead, but hopefully we can answer some of the questions above.

EXHORTATION. Our friends often mock exhortation, but on occasion exhortation has been used fairly effectively, often coupled with monetary incentives: smoking has gone down, and recycling up in the US in part due to exhortation. (When our kids were in kindergarten they told us how recycling is better than rubbishing, so clearly the education campaigns start young). How much of the change is due to changing mores and social preferences, and how much to cigarette taxes or trash collection discounts for recycling is hard to say. On the other hand, modern campaigns to encourage transit use and carpooling have been notable failures.

RATIONING. Rationing seems fair, and is used in many megacities throughout the world, either rationing the total number of vehicles, or the days they can be driven. During World War II, the US rationed rubber tires and fuel. Rationing however often devolves into a black market (and thus pricing), as people pay for rations. For instance there is a large market in license plates in cities that have day of week license plate rationing.

If your license plate ends in an odd number, you can travel Tuesday, Thursday, Saturday, and Sunday. If it ends in an even number you can travel Monday, Wednesday, Friday, and Sunday. Therefore each weekday will have half as many travelers, right?

Alternatively, license plates ending in 1 or 2 can't drive on Monday, 3 or 4 can't drive on Tuesday, and so on. Therefore each weekday will have 20% fewer cars. Mexico City introduced 'Hoy No Circula,' or Do Not Drive, in 1989 to combat air pollution, and



Figure 5.3: Is your journey really necessary? Railway Executive Committee.

extended it to curtail weekend driving in 2008. It is viewed as being fairly successful, but not without concerns.

This strategy is similar to one used in the some US states to ration gasoline during the oil crises of the 1970s, keeping people from buying gasoline on the wrong day. In practice, people with money (which is to say, most people with cars) get a second car to travel when they want. People swap cars, or license plates. People get around these regulations, which are a terribly inefficient way to reduce congestion.

PRICING. The best strategy for addressing traffic congestion is charging for the use of streets. Road pricing is slowly being adopted by more cities globally. London and Stockholm are well-known examples, and many US toll roads are experimenting with peak hour pricing, mostly on Interstates. The big opportunity for change in the US comes with fleet electrification, which requires switching away from the gas tax (since electric vehicles do not use gasoline) as a source of road funding. This topic is sufficiently large and important, it deserves its own [chapter](#).²⁷

Charging people for the use of roads, more when and where it is congested, less when and where it isn't, will foremost reduce travel during congested times, and thereby reduce congestion, and may increase it in uncongested periods when there is excess capacity (depending on the charge) as people adjust their schedule. This better balances the load on the network, and is a strategy undertaken in most transport modes, as well as other time sensitive businesses like restaurants and movie theaters.

- How do travelers reduce travel? This is the best part. Each individual decides for themselves when to change location, when to change schedule, when to work from home, when to have something delivered rather than making a trip to get it, when to use a different mode, when to share a ride, when to reroute, and when to forego a trip, thereby making decisions that are individually rational.
- Doesn't this lose road agencies money? This is the second best part. With pricing, properly regulated road organizations, perhaps constituted as [utilities](#),²⁸ will see roads as a valuable commodity rather than a commons, and if they increase throughput more they can sell more. They will try to be more efficient about managing the use of the existing roadscape, but won't have an incentive to build unnecessary new links.

²⁷ §6.

²⁸ §19.

- Can this work? This is the third best part. There are many proposed strategies to implement pricing. Obviously this has been politically difficult, or it would already be widespread. Transforming road agencies into public road utilities is one step. Further, the emergence of electric vehicles and the advent of autonomous cars reopens the window of opportunity to consider pricing to replace gas taxes, and enable road demands be managed far more directly.

There are undoubtedly some pet solutions out there not discussed here, and lots of details overlooked.

6

Pricing



Figure 6.1: Singapore Electronic Road Pricing Gantry. Photo by D. Levinson.

In fairness, the people who drive on a road should be charged for the service received, and in proportion to their use of the service.¹

¹ (Friedman and Boorstin 1996).

When Milton Friedman and Daniel Boorstin wrote those words in 1950, the Interstate Highway System did not yet exist. Roads generated more benefits than they cost, but were insufficient for America's needs. A new generation of toll-funded inter-city turnpikes was being developed by states. The federal gas tax was on the order of \$0.015/*gal* in 1950s dollars.

The designers of the Interstate Highway System that began construction just a few years later could not have known what route you would take from your home to your workplace today. But they

did know which roads, and which kinds of roads, increased accessibility, and so they built a network that made it easier for people to reach the gamut of constantly varying potential destinations. Those highways directly connected places that had been only circuitously linked, sped travel by upgrading traffic lights to interchanges, and added lanes to reduce congestion.²

² The most important of today's roads (about 250,000 *mi* (400,000 *km*) across the US) have been designated as part of the National Highway System, including the 46,000 *mi* (74,000 *km*) Eisenhower Interstate System.

³ §7.

That highway system is largely regarded as successful. Though it accounts for about 1% of US road miles, the Interstate carries about a quarter of all travel. This success comes with costs³ for such heavy use; costs borne by drivers and people nearby.

We in transport economics generally say roads are underpriced and travel is heavily subsidized by society at large. As a result, we over-consume travel. The solution is raising the price of travel. Pricing comes in numerous flavors. It might be very precise to time and location, or might be in selected areas or inside of defined cordons, or on selected facilities, or at selected times of day, or everywhere, with tolls varying by distance.

High-occupancy/toll (HOT) lanes that charge by time-of-day on selected facilities may guarantee that a particular facility is uncongested (by limiting demand on that facility). This is as much pricing for reliability as pricing to reduce congestion. The political advantage of HOT lanes is their voluntary nature, and the untolled alternative. We could certainly extend this to truck-only toll lanes (TOTs) and perhaps to some other domains.

The London Congestion Charge affects most traffic entering Central London, regardless of time-of-day or distance traveled. The general sense is it has been successful, but a poorly conceived extension of the charging zone from central London to the west was reversed by then mayor Boris Johnson.

In Germany heavy goods vehicles pay to travel on the autobahn, though cars travel for free. Higher tolls for trucks are common on US toll roads.

⁴ (Westervelt 2018).

Some people have even proposed paying people not to drive.⁴ We suspect this would induce people to pretend to drive who otherwise would not have in order to receive the reward for not driving.

Some travelers benefit more than others, and one of the arguments about road pricing is to provide a way to discriminate between trips of different value, encouraging travelers making low value trips, once peak hour tolls are imposed (and thus at now expensive times) to change their behavior. Travelers making high value trips will pay the toll and save time.

Without tolls, travelers still have different values, but we have no means to differentiate them, and all travelers (rich and poor, those

in a hurry and those not, workers and retirees) sit in traffic together without good alternatives. By pricing more in the peak (and less in the off-peak) flexible travelers will switch travel times from when capacity is fully utilized to when there is spare. Of course, *induced (or reduced) demand*⁵ operates in all cases, but that can be considered when setting prices.

⁵ §14.

Road pricing has been unsuccessful to date because it is framed wrong. We say it is ‘unsuccessful’ because it is not widely adopted, despite being a policy proposal on the table for decades, despite its widespread support among transport economists, transit advocates, and others. Unfortunately, it is perceived (by drivers and politicians) as punitive.⁶ The cover of this book shows rioters smashing a toll gate during the Rebecca Riots.⁷ The events in France in late 2018 suggest raising the price for transport (in that case, with a carbon tax raising the price of petrol and diesel), remains politically challenging. There is a large and growing literature on the acceptability of congestion pricing.⁸

⁶ As we mentioned in *dogfooding* (§17.6), few officials in charge of transit are transit users. They are drivers, so even in places like New York City officials take the *view from the windshield*. They see themselves as the subject of the toll more than others who would benefit.

⁷ (Williams 1955).

⁸ (Giuliano 1992; Schade and Schlag 2003; King et al. 2007; Hårsman and Quigley 2010; Börjesson et al. 2012).

Road pricing has two complementary objectives, raising funds and allocating scarce resources like roadspace. Pricing programs can be designed to manage (or even eliminate) congestion, but congestion reduction is not necessarily an outcome of road tolls. We already raise funds for roads with gas taxes. Gas taxes are in the present (non-EV) world almost perfect as a fund raising mechanism, as they don’t have much in the way of administrative costs, but they are poor at reducing peak hour travel.⁹

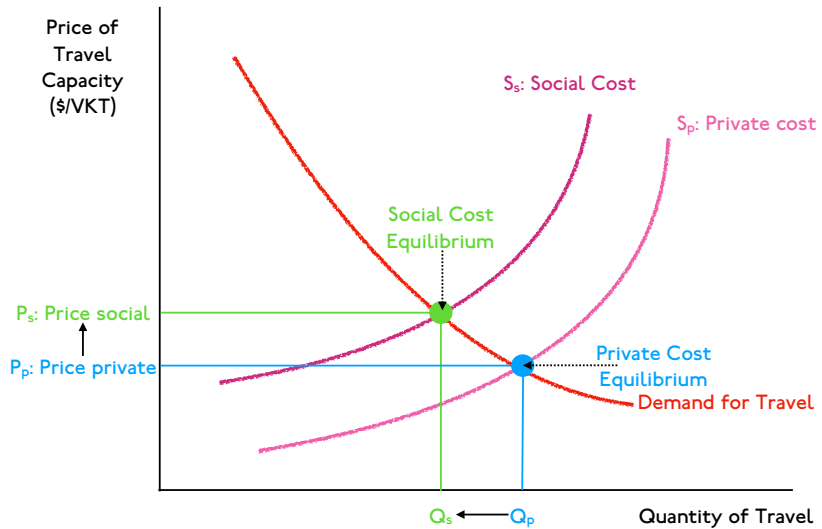
⁹ (Wachs 2003).

The economic ideal is called ‘marginal cost pricing,’ which charges drivers a toll equal to the marginal cost of the additional delay they impose on other users. This is the difference between the social and private prices that travelers pay: $P_s - P_p$ in Figure 6.2. If this revenue were reinvested in infrastructure, under certain assumptions, we have what is called a ‘self-financing rule’ that says the revenue from pricing will pay for the cost of infrastructure at optimal investment levels.¹⁰ Unfortunately, this ideal runs into many practical difficulties for widespread use, especially outside of city centers and off-freeways, where the vast majority of roads lay. In the absence of pricing, ‘second-best’ solutions for financing have been proposed, these range from a ‘vehicle mile tax’ or ‘mileage-based user fees,’ cordon charges and congestion charging zones (as in London), HOT lanes, and so on. The gas tax can be seen as a second-best pricing mechanism that does not differentiate charges by time-of-day or location.

¹⁰ (Verhoef and Mohring 2009).

We of course might want more funds, but we believe we should not raise revenue and switch methods at the same time. If we want

Figure 6.2: Technical Externality (Costs).



to switch methods (to better allocate roadsapce) we need to be revenue neutral. If want to raise revenue, we should raise rates under whatever system is adopted. These two debates should not be conflated.¹¹

¹¹ Politicians of course see the advantage of conflating issues.

6.1 Temporal variations

The critical aspect of urban travel is its peak by time-of-day. We have morning and evening rush hours, corresponding to when most people go to and from work. However, there is a lot of non-work travel in these periods as well (especially in the afternoon): people collecting and distributing children, going shopping, to the gym, or eating out, who may have more sensitivity to price than people going to work. We can see peaking in Figure 6.3. Demand for work travel peaks in the morning and evening (non-work trips are flatter, but not flat). Speeds drop in the morning and afternoon peaks. If we balanced the load more evenly, average speeds would rise in the peak and drop in the off-peak. But the net should be an overall gain, since there is excess off-peak capacity.

Therefore, the primary objective of any new road pricing strategy should be to better balance loads, i.e. manage the use of a scarce resource, roadsapce, during the peak hours. Basically we want to move some drivers from the peak to what transport analysts call the ‘shoulders’, either just before or after the peak, to the off-peak, to the weekends, to another destination if feasible, or to some other mode (transit or telecommuting, for instance).

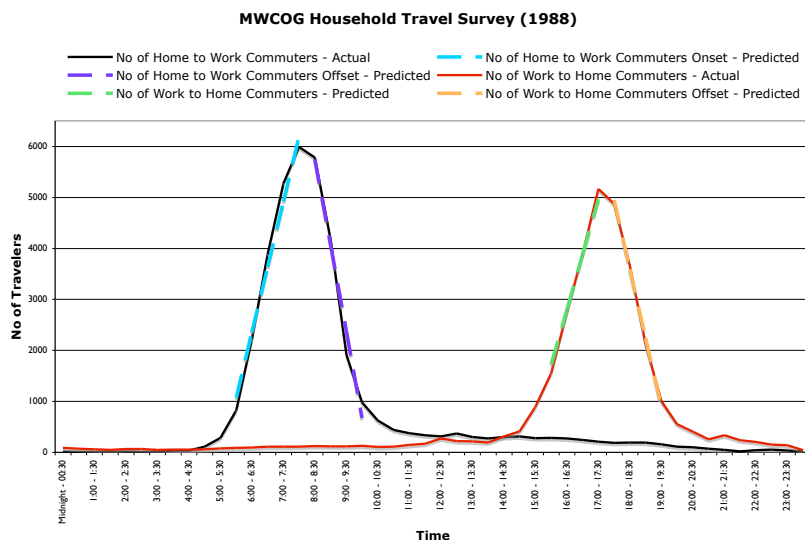


Figure 6.3: Temporal Variations. (Parthasarathi et al. 2011).

Because it is costlier to provide extra road capacity to support travel in the peak, and because of congestion externalities, travelers in the peak should pay more than travelers in the off-peak to satisfy both equity and efficiency arguments.^{12,13} Currently most federal and state road funding is from a gas tax that is proportional to fuel consumed, more or less proportional to distance traveled, but almost entirely independent of when that travel takes place (more fuel may be consumed per mile in the peak than the off-peak because of additional braking events in stop-and-go traffic, but this is too small to affect people's behavior).

6.2 Spatial variations

Just as we want to balance trips across time-of-day, we might want to balance trips across the network. While during the peak, some links are congested, others have spare capacity. Perhaps we can move travelers around?

Work in our labs with computer models of the Twin Cities road networks shows that moving from a user equilibrium solution, where each driver selfishly chooses his or her own route, to a system optimal solution where each driver chooses a route that is best for society, reduces total Vehicle Hours Traveled by less than 5%.¹⁴ This suggests there is not much to gain for all of the complexity involved in getting travelers to switch routes, but keep their time-of-day.

¹² Congested traffic also results in more pollution due to stop and go travel. (Zhang and Batterman 2013) After the installation of EZ-Pass electronic tolling in New Jersey, which allowed drivers to pay a toll without stopping at a toll booth, fewer babies born to those who lived nearby has low birth weights or were born premature (Currie and Walker 2014).

¹³ Ironically, perhaps, additional travel by public transport in the peak may be less expensive than in the off-peak, as the high fixed costs of tracks and vehicles, and the costs of drivers, are spread across more users in peak times, so long as the system is not fully utilized.

¹⁴ (Levinson et al. 2018).

VARYING TOLLS BY TIME-OF-DAY MATTERS MORE THAN BY PLACE.

6.3 *You can toll some of the roads some of the time ...*

One way of raising the price of travel is tolling new roads rather than letting them be free.

SCENARIO: A PRIVATE TOLL ROAD. This road sets a profit-maximizing toll, subject to regulation, in a world where travel on other roads is ‘free’. Because the road would not have been built but for the private investors, this regulation will typically have been negotiated in the franchise agreement to be a light touch, so tolls will be close to profit maximizing. Since this is not a competitive market as taught in Econ 101, profit-maximizing tolls are not welfare-maximizing, and instead will likely be too high.

Given that drivers have alternative untolled roads, imposing tolls on the toll road that are too high will thus drive vehicles away from this road and onto other roads, which will be more congested (and polluted) than necessary. Total travel overall will be higher than without this road. However on competing routes, travel will be slightly lower (recognizing induced demand eats up some of the capacity, though consumer surplus should still rise), than if the road did not exist, so this capacity, compared to its absence, generally improves the transport welfare (consumers surplus) of travelers. However, this priced capacity, compared to it being free, reduces the transport welfare of travelers.

Based on their history, individual toll roads are not an especially good business to invest in.¹⁵ They are high risk and the forecasts cannot be trusted. New toll roads have tended to over-estimate demand and under-estimate costs. Eventually they need to pay their creditors, and the investors get wiped out. The good news for the public is the roads continued to operate, despite bankruptcy. There are many reasons for this, but pity not the toll road builders, they do it to themselves. Governments have also bought out privatized toll roads to get out of poorly written contracts, like the 91 freeway in Orange County, California, which was acquired so the public could expand the parallel free lanes, which had been blocked by a non-compete clause.

¹⁵ See for example, the cases of the Dulles Greenway outside Washington, the privatized Indiana Toll Road, Texas SH 130, San Diego’s South Bay Expressway, the Greenville, Southern Connector, and the Pocahontas Parkway in Richmond. In Australia, the Clem7 toll road and Airportlink toll road in Brisbane, and the Lane Cove Tunnel toll road and the Cross City Tunnel toll road in Sydney went under. In Spain, the Madrid-Toledo highway went down a similar path. For a more formal treatment, see (Bain 2009; Flyvbjerg et al. 2005).

SCENARIO: ALL ROADS TOLLED. Tolling all roads requires the cooperation of the road owners, almost universally involving multiple levels of government.¹⁶ While the system might be administered *under contract*,¹⁷ it will undoubtedly be at worst regulated like a monopolistic utility, with cost plus rate-of-return rates. The costs might include *externalities*,¹⁸ and not just direct costs, or maybe the externalities will be taxed separately (such as carbon taxes at refineries or mandatory car insurance). These tolls will be close to welfare-maximizing after covering costs (though the welfare-maximizing toll may not cover costs, depending on the shape of the cost function and whether the road is congested).

Still, the key point is that tolling some of the roads may very well be worse than either tolling none of the roads or all of the roads. It introduces distortions, may result in new underutilized capacity in an environment where other roads remain congested, and discredits the premise of pricing in the mind of politicians and voters. While incrementalism is generally a good strategy, the steps need to be in the right direction (for instance, tolling *all* of the roads *a bit* may be better than tolling *some* of the roads *a lot* and *others not at all*).

6.4 *You can toll some of the cars some of the time: Phasing in road pricing one vehicle at a time*

There are several issues that keep getting ignored by those endorsing quick implementation of road pricing.

- Gas taxes send the right signal about general use, and encourage conversion from gasoline to electric powered vehicles if set appropriately, though does not send a useful signal for time and place.¹⁹
- Gas taxes are administratively efficient, road pricing loses on the order of 20-30% of revenue to administration and collection costs.²⁰
- Imposing a new mileage-based user fee/road user charge/vehicle mileage tax on existing vehicles is going to be unpopular, probably less popular than simply raising gas taxes.²¹

Yet everyone now recognizes gas taxes will cease to be effective as user charge as hybrid and EV adoption rises (even if the gas tax rises with fuel economy, eventually the fleet will be nearly 100% electric). If we rely only on gas taxes, we eventually will have to tax 100% of the cost of roads on the last gasoline powered vehicle. The system will *break down*²² long before then.

¹⁶ Government cooperation is also hard. In New York, there are five public toll setters, none of which set tolls with regard for the others. So Port Authority of New York and New Jersey tolls have been increased independently of New York's Metropolitan Transportation Authority's toll increases. As a result, models often get it wrong as the case of multiple toll setters is not considered. Serial monopolists along a corridor impose even higher tolls than a single monopolist would. (Levinson 2002).

¹⁷ §18.2.

¹⁸ §7.

¹⁹ (Wachs 2003).

²⁰ (Levinson and Odlyzko 2008).

²¹ (Millward 2009).

²² §3.

Still, road pricing has proven difficult to implement, but this is changing as other traditional sources of revenue are stagnant. Since any transition to electric cars, which are not subject to the gas tax, would force consideration of new sources of revenue anyway, they raise the opportunity of a gradual transition without the high political and implementation risks of a sudden shift in policy. Moreover, the higher the gas tax, the faster a transition to electric cars will occur.

²³ In fact, many automakers have already declared a year after which their entire fleet will be electric. Volkswagen says after 2025, for instance, they will no longer develop gas powered engines. As of now these are speculative claims, but claims nonetheless.

This suggests an obvious transition point.²³ Use gas taxes to collect revenue from the *old fleet* powered by gasoline or diesel, use some form of distance-based road pricing (with an off-peak discount) to collect revenue from the *new fleet* powered at least in part by electricity. It can be easily communicated that the new fleet does not consume gasoline (or as much) and this is about fairness. The relative gas and electricity charges can still be skewed to adjust for environmental externalities associated with gasoline, but other than that, should be equalized to reflect costs imposed and benefits received. A standing, independent *Highway User Fee Commission* can set federal rates to ensure full funding of the Highway Trust Fund (and secondarily manage traffic by time and place). States could piggy-back on the apparatus.

Each new electric or quasi-electric car can have an on-board device to compute tolls specific to the vehicle (based on fuel economy, and therefore discounting for the gas tax already paid) and for time (hour of day, day of week) and general place (in the city, on the freeway, vs. in the country, on local roads, etc.). Since this would apply only to new cars, no older EVs would be harmed (it is a small price to pay for political harmony).

Trucks are another story, since the fleet is smaller and more centrally managed.²⁴ They can be converted sooner.

²⁴ Some large truck fleets have a great deal of central management, others give drivers more latitude. Many trucks are owner operated, and thus more similar to cars in their management.

WE SHOULD PHASE IN PRICING ONE EV AT A TIME. We propose that all new Electric Vehicles (EVs), Hybrid EVs, and other Alternative Fuel Vehicles (non-gasoline and non-diesel vehicles) participate in a new road pricing system. All such vehicles would qualify for rebates on general tolls, local property taxes, or other general-revenue sources of road funding, as well as any gas tax paid (in the case of Hybrids). And they would be equipped with the devices necessary to participate in automated road pricing. This would give the automakers an opportunity to implement the necessary devices into a small fraction of their cars at first, ensure that bugs and difficulties were discovered early, and inconvenience only a small portion of the population that would knowingly

choose to participate in this gradual experiment. It would also give the government the chance to set up a revenue collection system that can over time cover a larger share of the fleet, and eventually the entire fleet (either as EVs and other Alternative Fuel Vehicles come to dominate or as all new cars are brought into the system). And it would both raise revenue and manage traffic, using discounted off-peak rates.

As more and more vehicles become non-gasoline powered, participation in this system would grow, allowing it to become more and more effective.

Such a proposal would have several major benefits:

- **Equity:** Requiring travelers to pay for the roads they use would be more fair, and many Americans would consider having wealthier people pay more to be more equitable. To date, early adopters of electric vehicles have above average incomes.
- **Implementation:** This strategy would avoid a big-bang implementation disaster. Information Technology is difficult, it is better to phase it in than try to do it all at once.
- **Choice:** Drivers of gasoline-powered cars should be allowed to voluntarily opt into this system, which for many travelers would save money. Policymakers should further allow an opt-in tracking feature, which would provide a discount in exchange for rates that varied locally. At the same time, owners of EVs should be allowed to opt-out in exchange for paying annually based on their odometer readings at the highest toll rate.
- **Rebates:** If there were a surplus at the end of the year, above the participants' total share of the cost of roads and rebating for other taxes, all participants in the system would receive an equal dividend.

WE SHOULD PHASE IN PRICING ONE AV AT A TIME. To paraphrase and update Russell B. Long:

Don't tax you, don't tax me, tax that robot down the street.

As with EVs, there are not many Autonomous Vehicles (AVs) on the road now, which makes it an ideal time to introduce pricing for this class of vehicles. While most AVs are likely to be EVs, there is no guarantee. AVs pose an additional risk, they can drive around unmanned. While wasting the driver's time is a disincentive to congesting the roads, wasting a robot's time is no such issue, and if driving were cheaper than parking (which might be the case on

²⁵ (Chase 2014).

unpriced roads in a downtown area), AVs might circle the block without parking waiting for their passenger. Robin Chase, co-founder of Zipcar, refers to this as the ‘hell scenario’.²⁵ While such a scenario seems absurd, it is only absurd because policy will quickly address it. And the means for addressing it is a prohibition backed by fines and heavy enforcement, or more generally, road pricing. While certainly a proactive stance will head off this outcome at the pass, a reactive stance is more likely, since we are talking about American local government.

6.5 *Billing systems*

The US’s largest telephone company, AT&T, has been described as a billing system attached to a telephone network. The point was, the complexity of the phone network was incidental to the amount of technology and effort required to bill for the use of that network.

²⁶ §19.

In contrast, road organizations often don’t have any billing system at all, and have no way interacting with their users. As they transition into [road utilities](#),²⁶ developing some form of revenue collection system from users (be it tolls or mileage fees, or indirect like fuel taxes) becomes essential to the operation. Billing closes the loop so that users who benefit from the system pay for the cost of that system, and the revenue generated pays for the infrastructure users benefit from. Billing will become a core competency for which there will be a penalty to pay for outsourcing.

Presently state DOTs typically have no direct revenue collection interaction with users. Turnpikes are often separate agencies, and gas taxes are similarly collected by third parties (from the oil companies, who collect it from consumers). But collecting revenue from customers is critical to transactions, and while once it was complicated to accept anything other than coins or cash, today even food trucks, independent publishers, and non-profit blogs can accept electronic transactions.

This is an important interaction with the consumer if done in person, or even remotely, an opportunity to manage the customer service aspects. While many utilities do this poorly (cable TV being the most obvious), it need not be.

Initially we will think of transport systems as charging per use. But there are many different services people may buy. For instance unlimited mileage, or unlimited off-peak mileage, or a limited number of trips per month with overage charges. All of these can be good for consumers, as it may save them money, or at least ensure the reliability of their price and travel time. It may also be useful for

the organization operating the system, as they can adjust prices in advance (with fewer surprises) in order to smooth out demand. Pricing will be far more sophisticated than a simple marginal cost price charged in real-time. This implies a relationship with customers. Further, there may be value added resellers, who consumers can deal with, who each have a particular number of slots on the system, and can develop other pricing strategies.

Closing the loop between benefits and revenue has several advantages.

- It builds confidence. People will clearly see that their payments go to pay for the utility, and don't get lost in the black hole of governmental general revenue. Even though gas taxes today are [hypothesized](#)²⁷ to pay for roads at the federal and most state levels, many if not most consumers are unaware and disbelieving. Yet few doubt the electric utility uses the money it collects monthly for generating, transmitting, and distributing electrons.
- It educates consumers. Transport users will see what transport costs to provide at a particular level of service at a particular time-of-day. The resulting incentives can only reduce consumption.
- It informs the agency. The agency will see what it does that provides value, and what doesn't. A revenue forecast will be coupled with demand forecasts. There will be a real penalty for mis-forecasting.
- It leads to better investments. The return on investment aligns directly with the agency's decision making process.

²⁷ §3.1.

6.6 Road service providers

Suppose, instead of purchasing road services from the government, (now via gas tax, later via mileage-based user fees), travelers purchase transport services (the right to travel at a location at a time for a price) from independent road service providers. Road service providers (RSPs) would purchase capacity from the infrastructure owner, presumably the government. This idea resembles Mobile Virtual Network Operators (MVNOs) in telecommunications industry, who lease capacity from network operators and then resell network services to customers. It also resembles internet service providers who sell bandwidth to consumers. If an RSP's customers over-consumed the road, the RSP would pay a penalty. The RSP would charge its customers accordingly to maximize profits in this new competitive market. What does this allow?

1. It allows competing RSPs to offer a variety of bundled services to customers (a per use charge, a charge for a the right to travel 10 times per month, or unlimited service, or service bundled with cell phones, or insurance or other services e.g), but to each have different bundles. RSPs are likely to be better at product differentiation and price discrimination than governments with omnipresent political and equity concerns.
2. It allows the government to stay out of the data ownership business, it would be responsible only for identifying which RSP a traveler subscribed to, and thus would eliminate 'the government is tracking me' problem with road pricing.²⁸
3. It provides new markets for private industry. This could be an app as part of a mobile phone or GPS or in-vehicle service (like GM's OnStar) or insurance (AAA, Progressive). The only technology standard that would need to be established by the government is a simple (such as RFID) sticker adjacent to the license plate verifying the RSP. The road owner would then deploy inexpensive RFID readers to count the number of cars on each link by time-of-day with the RSP. The private firms would be responsible for monitoring their own customers.
4. It provides a more stable revenue stream from government, which receives revenue directly from RSPs who bid on road space. In congested areas, road space would go for a higher price, in uncongested areas, RSPs would negotiate a per-use charge with governments.
5. Equity concerns of such a program could be mitigated through direct subsidy to travelers. Similar to how low-income people can get assistance for phone service or heating bills, people could qualify for aid based on need. We offer assistance for phones and heating because we treat those services as necessary. We should treat mobility the same way. Matt Caywood and Alex Roy argue for Universal Basic Mobility as a Human Right.²⁹ Assistance could be paid from some of the revenues raised.³⁰

²⁸ We still have 'the big business is tracking me,' but for holders of cellphones or credit cards, that game is already lost.

²⁹ (Caywood and Roy 2018).

³⁰ Alternately, travelers could use tradable credits, where driving would cost many credits while walking would cost none, and the overall cost of travel would depend on how spatially intensive and congestable each mode is. People who conserve their credits by walking or taking transit could then sell their credits to people who want to drive. A similar scheme has been explored for congestion pricing. (Kockelman and Kalmanje 2005).

One can poke some holes (faking RSP, like faking insurance or fake license plates or fake drivers licenses), but the idea is worth exploring.

VEHICLE LEASES: A NEW VECTOR FOR ROAD PRICING. The ownership model under Mobility-as-a-Service (MaaS) has often presented the dichotomy of an owned autonomous vehicle, the way Americans most typically use cars, vs. a shared autonomous vehicle

(autonomous vehicles that come to you like a taxi). But many automakers are now trying to move customers to the leasing model of vehicles, which gives owners a long-term stake in an individual car, but not full ownership rights. The reasons a customer may prefer a lease is that technology is rapidly changing; who wants to get stuck with an out-of-date vehicle?

Alternatively, drivers may anticipate their tastes or needs will change, and don't want the hassle of resale. Automakers have often leased things like Electric Vehicles which require a major overhaul at some point in time, and this also gets them a built-in service business, as the incentive for a lessee would otherwise be to not service the vehicle and run-down capital stock, while the lessor wants to maintain capital so they can re-lease (or sell) the vehicle subsequently after the expiration of the lease.

Moving automobile ownership to the lease model, particularly with EVs, provides another advantage, this one for the road administrators. It reduces the number of players who own cars and makes a new model of road service provider possible.

The lessor may be a road service provider or contract with one. Part of the lease can include terms about when and where you can use the road. Just as lease terms today allow X miles per year, new terms could be Y peak hour miles, and Z off-peak miles. The automaker/vehicle owner would then compensate the road owners for use of the roads by the cars they lease-out, while setting rates and incentives for vehicle users/leaseholders to manage their demand. Private firms would be able to explore demand space and develop interesting combinations of services (the price for traveling on certain facilities at certain times) in a way that the public sector just cannot do for issues of both capability and fairness.

6.7 *What about the revenues?*

An obvious potential benefit of road pricing is revenues. Private firms compete for privately operated toll roads because there is profit in some of them. States and counties receive revenue under these arrangements, either in up-front payments or annual rents.

We argue that these revenues, whether collected through private firms or directly through tolling, can and should be used to generate political support for pricing. If all we want to do with road tolls is to reduce congestion and create environmental benefits, then it doesn't matter if we dump the money in a giant pit in the countryside.³¹ A better use of toll revenue, however, is to use it to pay for services the public values, including subsidy to those who need it.

³¹ A giant pit of cash, however, is not something that the public will typically support. (*The Onion* 2008).

Assuming the the revenues exceed the costs of collection and facility maintenance, they should be used in a way that increased political buy-in for tolls in the first place. Consider that the political problem with tolls is one of implementation. People object to paying for something that is currently free. However, once toll revenues have been put to use, they have proven to be popular. So earmarking some money to get political support is warranted and good policy.

One downside to using toll money to generate political support is sometimes the public doesn't believe politicians when they say they are going to do something. Implementing a controversial new policy introduces a credible commitment problem. Lack of credibility has helped derail congestion pricing attempts in Los Angeles and New York City.³² Years of broken promises and diverted earmarked revenues to avoid raising taxes makes voters less likely to support new tolls.

For road tolls, credibility is additionally harmed as drivers understand the direct costs the tolls will have on their wallets, yet the benefits are less certain. Drivers don't know how they will benefit directly (what is congestion is reduced for someone else?), and may not think they will at all. There are solutions to these problems. Stockholm trialled congestion pricing before voting on it.³³

One idea is to send money generated by tolls back to the cities where the tolls were collected.³⁴ This would compensate based on spatial factors, and provide resources for cities to add additional barriers or landscaping that may alleviate some externalities of the roadways. Or money could be rebated to residents or reduce taxes some other way. These strategies will work best when the entire road network is tolled. In places where a cordon toll is applied, where the money should be invested is better defined. London is an example of the cordon approach. To build support for their congestion charge London invested in bus service prior to implementing the charge, though the charge affected relatively few commuters.³⁵ London's charge also fell on a small share of travelers as only about 12% of commuters to central London drove prior to the tolls.

6.8 *Planning with prices*

Transport systems should use prices to allocate resources. Pricing appropriately is an accessibility enhancing measure that creates incentives for the public to build fewer mobility-focused roads and

³² (Manville and King 2013).

³³ (Börjesson et al. 2012).

³⁴ (King et al. 2007).

³⁵ (May et al. 2010).

travelers to use more efficient modes. Marginal cost pricing for travel will have additional benefits in that demand for infill development and density will increase as people will seek to minimize their (higher) transport costs. To be effective, however, transport prices have to be set with a clear goal in mind – the objective is not simply to raise revenue for a pet cause or punish drivers. Prices should reflect the cost of building and maintaining infrastructure, plus the costs borne by society.

Since increasing the cost of driving is akin to a new tax that is widely shared, strategies that improve political buy-in are needed. An important caveat is that political support is not the same as public support. Politically, things are done all the time that a majority of voters oppose. There is no shortage of obviously good ideas that sit on shelves because no one will be their champion. Using revenues to bolster support is a necessary but not individually sufficient approach. Using revenues to minimize inequities is also wise, but unlikely to overcome public opposition. After all, laws are passed all the time that harm equity (no matter how defined).

Ultimately, the biggest obstacle to road tolls of any kind is status quo bias. People like the way things are more than they like change, even if change will bring many benefits. There is a typical policy approval cycle that takes political courage to weather.³⁶ Policies start out as ideas that will be implemented at some point in the future. Politicians will talk up the benefits at this point and minimize the costs, and everybody is happy. As a policy idea gets closer to implementation, details are revealed and people start to pay attention to what is being sold. For road pricing, this results in declining popularity. It is at the point of implementation that pricing is least popular, generally followed by favorable feelings once prices become the new status quo.³⁷

6.9 Congestion is over! If you want it

In short, to paraphrase John Lennon and Yoko Ono, Congestion is over! If you want it.

Congestion is over, if you want it.
Pricing is the answer and you know that for sure
Pricing is a flower
You got to let it, you gotta let it grow

We could have accessibility without (or with less) congestion, but we don't want it badly enough. The choice is really congestion *or*

³⁶ *Yes Minister* episode Six: 'The Right to Know' written by Antony Jay and Jonathan Lynn has this explanation of 'political courage.'

Sir Humphrey: If you want to be really sure that the Minister doesn't accept it, you must say the decision is "courageous".

Bernard: And that's worse than 'controversial'?

Sir Humphrey: Oh, yes! 'Controversial' only means "this will lose you votes". 'Courageous' means "this will lose you the election"!

³⁷ (Eliasson 2014).

pricing, and the political cost of pricing has to date outweighed the political cost of congestion. We don't value the time savings of accessibility enough for politicians to do the things necessary to save time. On the other hand, voluntary tolls (HOT lanes, TOT lanes, and so on) are more politically acceptable, giving people travel time reliability for an uncertain price, which is better than nothing, but certainly not optimal from an efficiency perspective.

In the absence of collapse of the existing system, widely deploying a new funding framework is fraught with difficulties. What we face now, despite all the protestations of crisis and catastrophe by those in the industry, is a slow bleed.

Indexing gas taxes to fuel consumption to ensure steady revenue (if consumption drops because of mileage improvements, taxes rise) is a good short-term (5-10 year) strategy. As is requiring EVs to join a road pricing system.

Getting from our current world to a slightly better one can be achieved calmly and rationally via white papers and deliberation, or through a real or politically generated 'crisis' (the preferred mode of governance in the US). A rationalist would certainly rather we went at this systematically, and so many people have played the 'crisis card' that there is 'crisis-fatigue.' However, politics does not seem to want to make transitions without some stress. Perhaps the rise of electrification and the collapse of gas tax revenue will be the crisis required to move to a new and different organizational regime in surface transport. But this is a slowly building crisis that could take the rest of our careers, and we are impatient.

The US is unlikely to be a first-mover in road pricing for political reasons. Fortunately there are many other countries. Unfortunately, only Singapore (see Figure 6.1) seems to be going all in on the subject.³⁸ We expect that until some small north-western European nation like the Netherlands or Norway, or a more culturally cohesive Asian country, like Japan, or more economically liberal Oceania country, like New Zealand, with their simpler politics, gets it done first, it won't happen in the US.

³⁸ London, Stockholm and a few other cities have limited congestion pricing in areas, but not full-blown road pricing.

7

Externalities



Figure 7.1: Car crash in New South Wales. Crashes are a significant externality of driving. Photo courtesy of NSW Justice and Police Museum.

Externalities are a hidden subsidy to transport. While we touched on external costs in [the Subsidy chapter](#),¹ we give more attention to those ideas here.

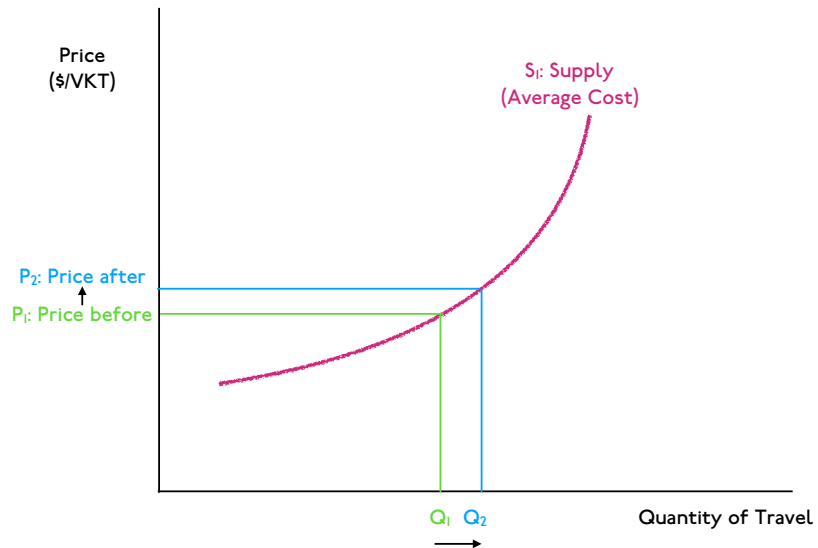
¹ §4

7.1 *Pecuniary and technical externalities*

Economics distinguishes between ‘technical’ and ‘pecuniary’ externalities. ‘Pecuniary’ is the SAT² word for relating to money, and the term ‘pecuniary externality’ covers cases where Alice’s presence in the market raises costs for Bob, who is also in the market. If we have an upward sloping cost curve, as we shift the demand curve to the right in quantity, the equilibrium price rises. Alice’s presence in a market (where variable costs are rising more

² SAT, formerly the Scholastic Aptitude Test, is a university entrance examination used in much of the United States.

Figure 7.2: Pecuniary Externality.



than average fixed costs are falling) raises prices for other consumers (all the Bobs), as shown in Figure 7.2.

³ The Minnesota Vikings are an American football club in the National Football League. They are called the Vikings because of the relatively large Scandinavian population in Minnesota.

The Minnesota Vikings³ stadium in Minneapolis's Downtown East drives up land rents for others. This pecuniary externality is not what we are concerned about. Instead we are concerned about 'technical externalities,' where someone's presence in the market creates an impact on someone who is not in the market. This is shown in Figure 6.2.

For instance the noise and congestion from a Vikings game lowers the property value of nearby residences. A backyard bike trail may lower property values.^{4,5}

⁴ Really, see (Mogush et al. 2016).

⁵ For a more complicated example, think about taking lanes from cars for a bike lane may increase congestion in the remaining car lanes. It is an imposition by bikes on cars, but it is internal to the transport system.

Just about any action has positive and negative effects on others who are not party to the transaction. In the absence of regulation, parties try to internalize the benefits and externalize the costs. The positive externality argument has been used to justify subsidizing many different goods and services.

7.2 Negative externalities

THE 'POLLUTER PAYS PRINCIPLE' SAYS THE BASELINE IS NO NEGATIVE EXTERNALITY. Under this logic, a polluter must pay a 'Pigouvian tax'⁶ equal to the cost of the negative externality to society. If reducing the externality were less expensive than the tax, the polluter will, of course, do that.

⁶ Named in honor of its promoter, Arthur Pigou (Pigou 1920).

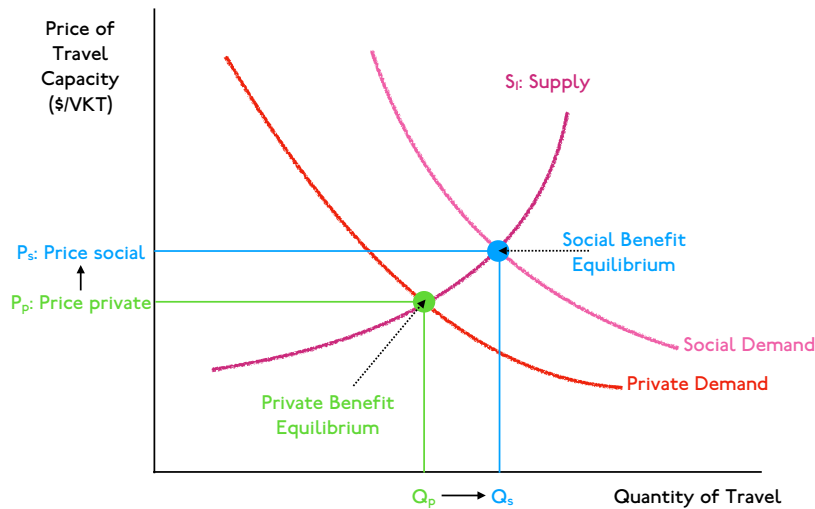


Figure 7.3: External Benefits.

If instead society were subsidizing someone to not pollute, (such as a cap-and-trade program, or congestion credits), we are reducing the negative externality, but systematically distorting incentives all around. We are changing the baseline from *no pollution* to *the existing amount of pollution*. We are in a sense giving a property right to existing polluters to continue polluting (congesting, crashing) the amount they want, and the victim is required to pay them to stop.

In contrast, 'Coasian bargaining'⁷ suggests we would wind up with the same efficient equilibrium when we can ignore transaction costs. Coasian bargaining may produce a poor set of incentives, especially if the polluter can game this system to increase their initial endowment by maximizing initial pollution in a way that is easily reduced for the polluter, but not obviously so to the polluted upon.

⁷Named for economist Ronald Coase (Coase 1960) who published until his death at 102 in 2010.

Currently drivers do not pay for the pollution, congestion, noise, or hazard that cars produce. They are thus being subsidized by the amount of their negative externality. This subsidy comes from the health sector in the case of pollution, from other drivers in the case of congestion, from property owners in the case of noise, and from other drivers as well as pedestrians and bicyclists in the case of hazard.

7.3 Positive externalities

IS THERE A DUAL PROBLEM? If the 'Polluter Pays Principle' is our operating logic for negative externalities, what is the appropriate

⁸ We will not argue about whether pollinating insects truly create positive spillovers.

analog for positive externalities? We will call someone who creates positive spillovers a *Pollinator*.⁸ So the operating logic is the ‘Pay the Pollinator Principle.’ In long form: The person or organization who creates positive spillovers (positive externalities) for society which they cannot themselves internalize, should be subsidized. This is shown in Figure 7.3.

⁹ (Bliemer et al. 2010).

THE ‘PAY THE POLLINATOR PRINCIPLE’ SAYS SUBSIDIZE POSITIVE EXTERNALITIES. In an experiment in the Netherlands, drivers were able to earn rewards by traveling during non-peak times.⁹ Whether this is a positive externality or a reduction of a negative externality is another question we discuss below. Assuming we could actually determine when a positive externality occurred (i.e. assuming perfect information), and that transaction costs were very small (i.e. we could implement it) the pay the pollinator principle might make some sense. Those two assumptions are at odds with how reality often works. Nevertheless, it is certainly used as a rationale for public subsidies for certain things like parks, schools, transit, bike lanes, NFL stadiums, even roads.

Unlike negative externalities which we clearly do not want, no one (or not everyone) necessarily asked the Pollinator to create a positive externality.

- If society subsidizes to induce the positive externality – then society is *asking*.
- If society subsidizes to reward the positive externality – then society is *thanking*, and implying an implicit incentive for future Pollinators. But these are different cases (before vs. after) with different results.
- If it doesn’t occur to society to incentivize or thank the Pollinator, but instead if the Pollinator demands a subsidy because of the benefits she claims to provide that the rest of us don’t (at first, or ever) see, that is another case still.

There are few cases where everyone benefits, and fewer where everyone benefits the same amount. A pro football stadium benefits place *A* and its businesses in large part at the expense of place *B* and its businesses. In short, most of the benefits are transfers, and while there may be a net social increase, there are winners and losers and the winners do not actually compensate the losers.

INTERNALIZE IT. While the Negative Externalizer has no incentive to capture their externality, why can’t the Positive Externalizer

capture the positive externalities? The Vikings, for instance, could have moved from downtown Minneapolis to a suburban location such as Arden Hills, Minnesota¹⁰ where they could own the land and put all the parking, hotels, shops, and restaurants on site, and the only spillover would be name recognition and municipal pride in a team so great they consistently bring home national championships regularly for the metro area they purport to represent.¹¹ By moving to (staying at) a smaller site in the city, they cannot capture all of the excess spending by stadium-goers, which instead spills-over to neighboring blocks in downtown, enriching nearby landowners and their tenants, and indirectly increasing the tax base (so it is said).¹²

So what is the difference between a request for more subsidy for bike lanes vs. more subsidy for a professional sports team?

As [Adam Smith recognized](#),¹³ public works like roads, and wide linear infrastructure in general, are notoriously hard to privately build without government consent or granting of eminent domain powers. Stadiums as point facilities are much simpler. A new network of bike lanes divorced from existing networks of rail and road infrastructure in a built-up area is impractical. In contrast, a new network of bike lanes in a private master planned community built upon a greenfield is readily accomplished.

In the absence of master planned communities replacing administratively obsolete cities cursed with an excessive division of property, a practical solution in the messy city needs to be identified.

IS THE GOOD UNDERSUPPLIED WHEN PAID FOR BY DIRECT BENEFICIARIES? Many goods have positive externalities over some range of quantity, but are not necessarily undersupplied once fully deployed. Network externalities are an example. Our use of the mobile phone network makes it more valuable for others. Our taking the bus makes bus transport more valuable for others.¹⁴ Similarly, our taking flights out of Minnesota makes air travel more convenient for others in the long run, as more flights will be supplied through Minneapolis, and hubs provide greater connectivity.

That doesn't necessarily mean that the public should subsidize our cell phone, bus trip, or flight even though we provide this externality we cannot capture ourselves. The private benefits are large, and after a certain point, public subsidy would not actually induce more consumption since the consumption is at the maximum level economically feasible. This is certainly close to true

¹⁰ Arden Hills is a northern suburb of the Twin Cities and a site the team wanted at one point for a stadium and development project.

¹¹ The Vikings were founded in 1961 and have never won a championship. They have lost four Super Bowls, and haven't made the league championship game since the 1970s. To be a Vikings fan is to accept that repeated failure is how you build character.

¹² In practice, when teams earn revenue from parking, suburban sites with ample land are favored. When teams don't have land for parking, they compensate with additional dining, shopping and paid amenities within the stadia. This internal activity is at the expense of external activities.

¹³ §1.

¹⁴ See discussion of the [Mohring Effect](#) §A.4 and ([Mohring 1972](#)).

for cell phones where networks were subsidized privately rather than publicly. There has obviously been significant public subsidy in the aviation sector, though today it is mostly privately funded. It is widely debated for mass transit.

Would we get fewer or smaller football stadiums when the football teams pay for it directly instead of with a large public subsidy?¹⁵ One could hope. Certainly the Minnesota Vikings have gamed the system to get a huge reward for little investment.¹⁶ Would the public thus lose benefits? This is not at all clear, as positive externalities are notoriously elusive.

HOW YOU SUBSIDIZE MATTERS. We can subsidize the consumer directly, by giving them cash or tax credit. Alternatively, we can subsidize supply, lowering the cost and thereby inducing more demand. These have very different effects.

7.4 *Are reductions of negative externalities positive externalities?*

We have seen arguments that bicycling has positive externalities, and thus society should subsidize it. The same argument applies to many things for which government subsidy is requested, including large stadiums for professional sports teams.

Stipulations:

1. Bicycles are not **public goods**.¹⁷ Bicycles are both excludable (with locks when not ridden, by the rider when ridden) and rivalrous (my riding prevents you from riding at exactly the same time and place), and are thus private goods. There are so many bikeshare firms precisely because they can sell access to bicycles.
2. Bicycle lanes may be public goods, since we don't generally have effective enforcement mechanisms to exclude people who do not pay from using bike lanes.¹⁸ Excludability for bike lanes is difficult with present technologies given their long and open nature. Similarly bike lanes are not generally congested, unless someone parks in one. The road paralleling such bike lanes may in fact be congested (rivalrous), and thus the demand for the space they use may be rivalrous – this usually varies by time-of-day.
3. Bicycling benefits bicyclists, otherwise they would not choose to ride their bike. So there are private benefits. (Similarly, professional sports teams are already profitable.)

¹⁵ The Minnesota Vikings, the Minnesota Twins Major League baseball team, the Minnesota Gophers college football team, the St. Paul Saints minor league baseball team, the Minnesota Gophers baseball team, the Minnesota Gophers women's hockey team, and the MN United FC soccer franchise all would up with different new stadiums in the new century, and the Target Center, home to the Minnesota Timberwolves NBA franchise (but not the Minnesota Wild NHL franchise), was remodeled, due to public subsidies and misaligned incentives.

¹⁶ This is true of all sports, but particularly egregious for American football as the stadia are so large (typically about 80,000 people or more) and used so infrequently (eight home games per regular season). The National Football League for many years held out the US's second largest metropolitan area, Los Angeles, which lacked a professional football team as a city where another city's team would move if no new stadium were built. LA lacked teams after the Rams (in LA from 1946) moved to St. Louis and the Raiders (in LA from 1982) returned to Oakland in 1994 (and will move to a new stadium in Las Vegas in 2020, perhaps leaving Oakland as the new market teams will threaten to move to). The Rams moved back in 2016. The San Diego Chargers returned to LA in 2017, having played there from 1959-1961.

¹⁷ §A.

¹⁸ While taxing regular bicycles is difficult, some cities are dealing with electric scooters and electric bicycles, which are faster than regular bikes. Since these vehicles look different than regular bikes, enforcement is a bit easier. For shared systems, some cities, such as Portland, have a tax per vehicle per day that is used to pay for infrastructure.

4. Based both on theory and evidence, the provision of bicycle infrastructure increases bicycle use and thus private benefits.¹⁹ Similarly, a new stadium will increase attendance or ticket prices at a sports event, at least for a 'honeymoon' period.²⁰
5. What a bicyclist would do if they were not bicycling is not obvious. Perhaps they would walk, or ride transit. Perhaps the trip would not be made (most trips are not work trips, and most bike trips are at least in part recreational). Does more bicycling actually result in fewer people using other modes?²¹

To the extent that fewer people drive or ride transit, at the margins additional bicycling reduces the negative externalities of those other modes (congestion, pollution, noise, etc.). (Similarly, what a fan would do were they not attending and spectating at a football game is not obvious. There would be at least some other leisure activity consumption.) This is insufficient to claim them as positive externalities for reasons discussed below.

DO TWO WRONGS MAKE A RIGHT? DO TWO MINUSES MAKE A PLUS? Back to the original question: Is a reduction of negative externalities from another mode (a benefit to society as a whole, if not necessarily to each member) a positive externality of biking?

Classic economic examples imply that it is a positive externality. One 'introduction to economics' website²² writes: "If you walk to work, it will reduce congestion and pollution, benefiting everyone else in the city." which is about as analogous as you can get. Yet something rings wrong.

The underlying logic is that 'negative' implies the minus sign, and if we reduce a negative we are adding (multiplying two minuses makes a plus in math even if two wrongs don't make a right everywhere else). From a simple welfare economics perspective, you will get the same Net Present Value either by more biking because you subsidized biking or you taxed non-biking.²³

Life-cycle analyses often look at indirect effects. When thinking about externalities, we need to distinguish between direct and indirect effects. To illustrate, when driving a car, tailpipe emissions are a direct externality. You may have purchased the car in a market transaction. The car was manufactured in a factory. The factory also had emissions. Are the factory emissions a negative externality of driving a car? If they are, how about the emissions of the steel factory which supplied inputs to the car manufacturer? How about the emissions of the worker who drove to the steel factory? How about the emissions of the food truck that supplied the steel worker's lunch? How about the emissions of the clothing factory

¹⁹ (Schoner and Levinson 2014).

²⁰ (Clapp and Hakes 2005).

²¹ The classic (logit) mode choice model implies that it does, though the shares are not 1:1, so we cannot assume that each bicyclist would otherwise drive. The Independence from Irrelevant Alternatives (IIA) assumption (Ray 1973) implies that if bicycling were somehow to disappear, bicyclists would use other modes in the proportion those modes have today, so maybe 60% of bike trips would switch to auto driver. More sophisticated models may be able to answer this question more accurately.

²² (Economicshelp.org 2018).

²³ Note that you will not necessarily get the same benefit/cost ratio, since negative externalities are a cost and positive externalities are a benefit, and the subsidy is a cost (to the government), and a benefit (to the traveler) and tax revenue a benefit (to the government), and a cost (to the traveler).



Figure 7.4: People like to look at unicyclists. Photo by D. Levinson.

that produced the shirt which was on the back of the driver of the food truck? If we accept the auto factory, we have no basis not to accept everything else in society, since the entire economy is a connected network. The usual rule in economic analysis is that we look at direct effects, not indirect effects mediated by market transactions. In this way we can focus on real effects and avoid double counting.

Thus reducing negative externalities of driving because you walk to work may be a wonderful thing, but *contra* our random economics-type website, it is not a positive externality of walking any more than the negative externality of the emissions of the factory worker driving to the shoe factory which supplied you with shoes. And any positive externalities of bikes should be associated with those direct effects of bicycling, not the indirect effects of other avoided things, nor should they be offset by the negative externalities of bicycle manufacturing and distribution.

We are not sure we can identify any direct positive externalities of bikes that are not mediated. Perhaps people like to look at bicyclists, who provide a positive aesthetic externality. (Actually, people do like to look at unicyclists, as in Figure 7.4, which is why circuses can charge money). Bicyclists are healthier, which reduces claims on publicly subsidized health care. However, this is not a direct positive externality since it is mediated by the health insurance market. The health claim also depends on local context, especially considering safety and injury and deeply breathing in the toxic emissions of cars. What would be true if everyone biked is not true if most do not.²⁴

Bikes are good, but they are mostly good because they are good for bicyclists. Like all other transport modes, we argue they should be funded primarily by user fees. One way to do this is through charges for secured parking.²⁵ Only if that is not feasible should other sources of funding be considered. However, since other modes are not fully funded by user fees, we are in the world of the second-best, and it would be unfair and inefficient for only bicycle facilities to be fully funded by user fees. We will say this just to be absolutely clear: drivers should pay the full social costs of their choice to drive.

SHOULD THE PUBLIC SUBSIDIZE INDIRECT POSITIVE EFFECTS? So then the question arises: Are these indirect positive effects worthy of subsidy?

Problems arise when the private beneficiaries are clearly identified (and organized), but the public beneficiaries are diffuse. This is a classic political economy problem, and explains why many special interests get tax breaks or subsidies. So the beneficiaries have an

²⁴ See (Hankey and Marshall 2015).

²⁵ Portland, Oregon, implemented a \$.25 charge for each trip made by a rented electric scooter to generate money to spend on new bike lanes. Tempe, Arizona charges scooter companies one dollar per scooter per day.

incentive to overstate the social benefit, especially when there is not a clear neutral arbiter of facts.

The net result may be over-investment in such facilities on the grounds of positive spillovers. This is obvious in the example of the Vikings stadium, which is far more than actually needed to keep the owners financially compensated for staying in Minnesota. While bicycle advocates will scoff at this premise in the present context, there are many examples of overbuilding in the history of transport. Just look at paved roads for cars and trucks, which at one time were in the same position as bike-only facilities today, and were clearly under-supplied. Today most bicycle advocates would assert such roads are over-supplied.

A second issue is the deadweight loss (the social benefit that is missed because of under-consumption) might be very small compared to the private benefit. This depends on the shapes of the curves and the magnitudes of the private and public benefits, both of which are unknown in practice.

SHOULD THE PUBLIC TAX INDIRECT NEGATIVE EFFECTS? In addition to indirect positive effects, there are indirect negative effects. The more people who rely on mode X, the more the landscape orients itself to people using mode X, the more difficult it is to use mode Y. For instance, automobile culture changes the landscape making it difficult to walk places, due to greater spatial separation, more danger for pedestrians, and increased delay for those walking, both due to network circuitry and delay at traffic signals. The spatial separation also implicitly imposes more *social isolation* on those without an automobile.

Making it harder to walk places no doubt reduces the amount of walking. Since walking is an activity that makes people healthier the more they do it, this undoubtedly has some impact on *physical health* as well.²⁶

But these indirect effects are mediated by markets, so accounting for them, and then taxing them, risks a large amount of double-counting.

ALTERNATIVES TO PUBLIC SUBSIDY: PHILANTHROPY. Public subsidy is not the only means for groups to obtain what they want when it is infeasible to do so privately. The not-for-profit streets.mn website²⁷ produces many social benefits, but is paid for by a relatively few members, compared to its thousands of readers. The readers must benefit, as they read. They probably benefit more than the private time and effort involved in reading. Yet they mostly

²⁶ (Ermagun and Levinson 2017).

²⁷ An early version of parts of this chapter first appeared on <http://streets.mn> as a blog post.

don't pay, and instead free ride (free read) on the efforts of others, and streets.mn is produced anyway. Life is a free ride on the efforts of our ancestors, who brought us fire, steam power, electricity, and the internet, among millions of other innovations.

²⁸ (Jaffe 2013a).

Why isn't transport itself philanthropically funded? While there have been discussions of philanthropically subsidized mass transit,²⁸ we are not aware of this actually being implemented at scale. One may argue the scale is too large. While that may be true for large public works, surely that is not true for bike lanes, which are relatively inexpensive to construct. In the early 2010s, bikeshare systems were often funded with a mix of philanthropy and user fees.

More likely it is because government already owns the roads, and thus the space out of which most bike lanes would be carved. Government is currently charged with building and maintaining roads, so that is the status quo. And if you can convince someone else to pay, why do it yourself?

7.5 Pollution ethics

"The needs of the many outweigh the needs of the few (or the one)."

– Surak

²⁹ The quotes were from the *Star Trek* movie *The Wrath of Khan*.

"The needs of the one outweigh the needs of the many." – Kirk²⁹

Case A. An individual releases toxic substances into the unowned environmental commons where it is breathed in by many members of the community for the individual's benefit and to some community-members' cost. This is pollution.³⁰

Case B. The community releases toxic substances into an individual where it is ingested by the individual for the community's benefit and to some individuals' cost. This is immunization.

Is A bad and B good?

A produces in economic terms a 'negative externality,' an unwanted side-effect on third-parties.

B produces a 'positive externality' (a good side-effect on third parties) such as 'herd immunity,' whereby the immunity of a significant portion of the population protects others from disease, as it limits the ability of viruses to spread.

So long as most individuals benefit from immunization, people seem to let it slide. But there have been a number of immunization attempts that were not generally successful, where the downsides may have outweighed the upside, the US 1976 Swine Flu

³⁰ Strictly speaking, pollution may also produce positive externalities. For instance, some agriculture may benefit from a change in the chemical composition of the air, or change in temperature, etc., these are often thought to be relatively small compared to the downsides.



Figure 7.5: Wall of Sound. Photos by D. Levinson.

immunization is an example, where the flu killed 1 person, and the immunization killed 25.³¹

Pollution exists and is known to cause harm. Most people think all else equal, pollution is bad for society. There is debate on how much to regulate or price pollution, as well as the magnitude of the harm caused from individual pollutants. In the US, air pollution in general is down, though decreasing some pollutants may increase other pollutants; processes that reduce the size of pollutants may reduce the number of large particulates but increase the number of small, less easily measured, particulates. It is known that vaccines have side effects, it is not known in advance which unlucky individual will be the recipient of those side effects.

If you are a communitarian, *A* is unacceptable, *B* is acceptable. If you are an individualist, *A* is acceptable and *B* should be voluntary. An individualist may willingly submit to immunization, but only if their personal benefit outweighs their personal cost, not strictly for herd immunity or for the benefit of others (unless those are things that they get salutary benefits from, either from a feeling of moral righteousness or from rising in status due to the perceptions of others). They believe society does not have the right to forcibly vaccinate individuals, or coerce individuals into vaccination in exchange for mandatory services like public education.

This is a [values question](#).³²

³¹ The story is more complicated, and those who were immunized in 1976 were less likely to get ill in the 2009 outbreak, so it may have been net positive in the long run ([Wikipedia contributors 2018a](#)). And of course, maybe the immunization prevented more widespread flu.

³² §20.

7.6 The art of noise

In 2012, there was a lot of noise in Minneapolis's Prospect Park neighborhood about a new sound wall erected on I-94 by the

Minnesota Department of Transportation (MnDOT). Some neighbors (on the north) complained about getting more noise as a result of the wall (on the south side of the highway), as the noise bounces off that wall and up to their house, which is above the noise wall on their-own side of the freeway (and where the wall is punctured by Franklin Avenue). The house shown in Figure 7.5 has a party of signs and balloons with various anti-noise slogans.

Noise is of course unwanted sound. Your music is our noise. It is a classic externality of transport, and in fact one of the most costly (its economic value may exceed the cost of air pollution). To reduce the amount of externality, transport agencies erect noise walls, reducing the amount of noise on the other side of the wall (and thus diminishing the decrease in property value). But that noise doesn't just disappear, it makes the road noisier, or as it is claimed in the above example, the north side of the freeway.

People can often adapt to a steady stream of white noise as on a crowded freeway, but it is the unusual noises (the one loud truck, the motorcycle, the airplane, the train) that are more disruptive and annoying.

Who has rights here?

When there is a homeowner, and someone moves in next door and makes a lot of noise, we often say the new neighbor is creating the noise externality. We often hear about the 'Polluter Pays Principle.' But Coase would say that but for the homeowner, there would not be an externality either.³³ This echoes the famous zen koan: if a truck roars on the highway and there is no-one there to hear, does it make a noise externality?³⁴ Either the homeowner should pay the neighbor to shut up, or the neighbor should pay the homeowner to get insulation and better windows, or the homeowner should accept the damages, or the neighbor should pay him for his damages – society is indifferent. What we need is a clear source of property rights. Who wins and loses in these two circumstances does change with the allocation of those rights. Managing these externalities (so that we can avoid expensive 'nuisance' lawsuits) is one of the important jobs of planning. Do we have a right to quiet, or do you have a right to make noise?

Airports often face the question with their neighbors. Clearly airplanes create noise. Should the neighbors be compensated? Well, if the neighbors moved in after the airport already made a lot of noise, they paid less for their house (or pay a lower rent) already, why should they be compensated twice?³⁵ If the airport is paying, then the airlines are paying, and if the airlines are paying, their customers are paying. But if the airport moves in after the

³³ (Coase 1960).

³⁴ More famously asked as: If a tree falls in the woods and there is no one there to hear it, does it make a sound? (Wikipedia contributors 2018d).

³⁵ This issue is complicated when flights paths are changed. At the Phoenix Skyharbor airport (PHX) flight paths were changed and new neighborhoods started complaining about noise – it is unclear if this would have been reflected in prices. Lawsuits are going to the FAA in this case.

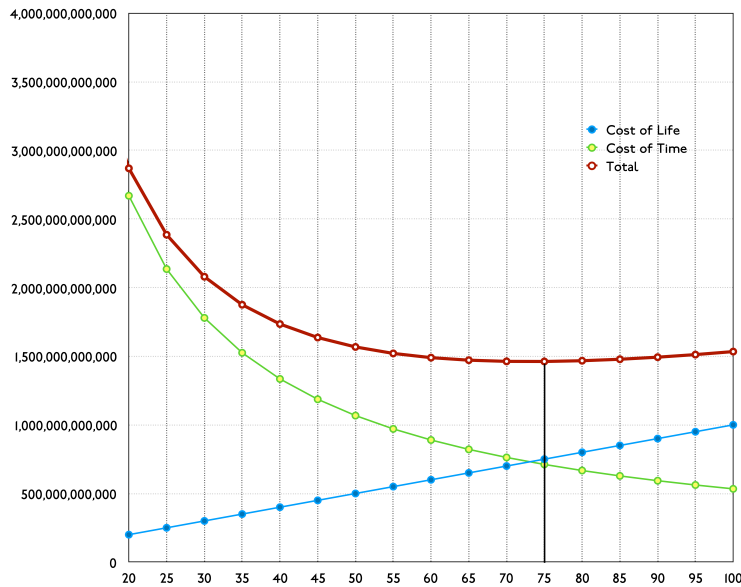


Figure 7.6: Safety vs. speed.

neighbors had already built their houses (and to help tilt the playing field, the airport had been zoned as a park previously so there was no airport-anticipation), we feel it should compensate.

In this case, maybe there is an inexpensive technical solution. Maybe there is an expensive technical solution.³⁶ Maybe MnDOT should buy out Mr. or Ms. Unhappy-with-Noise and resell the house at a noise-affected discount with a noise-easement. Maybe Mr. or Ms. Unhappy-with-Noise will just have to live with a noisier world.

7.7 Safety vs. speed

How fast should we drive? From a social cost perspective, faster speeds save time, which has a value, but faster speeds cost lives, a negative externality which also has a value. To illustrate the trade-off we did some back of the envelope calculations, imagining, like a macro-economist, a single road represents the whole transport system. Annually there are about 30-40,000 people killed in the US, there are 5.1 trillion annual vehicle kilometers traveled.³⁷ The average speed of travel isn't known directly, but if we assume the average person travels in a car 60 minutes per day (the 1 hour travel time budget) this implies, at approximately 48 km³⁸ of travel per day per traveler, about 48 km/h, which seems about right (including about one-fourth of travel on freeways at higher speeds

³⁶ Technical solutions include free soundproofing, as happened in the Twin Cities. Economists have suggested selling noisy houses to deaf people. In the Daredevil TV show on Netflix, Matt Murdock got a great deal on a New York apartment because he's blind so didn't mind the neon signs outside his windows.

³⁷ 3.2 trillion annual vehicle miles traveled.

³⁸ 30 mi

and three-fourths on surface streets and roads at lower speeds, and including traffic signals). As the saying goes, ‘Your Mileage May Vary,’ and this is intended to be indicative – not a universal answer.

Some additional assumptions:

- We take the Value of Life to be \$10 million and assume fatalities are the only cost associated with crashes (they are about 78% of total crash costs according to our analyses, so we should inflate this number to get total crash costs).³⁹
- We take the Value of Time to be \$15/hour.⁴⁰
- We assume the number of deaths drops linearly with speed, to zero at zero speed. The improvement is likely non-linear, as reductions in speeds from high speeds are more valuable than from low speeds.
- We assume the value of travel time savings is constant, independent of the amount of time saved.

To be clear, these are huge assumptions. Examining the figure we see the lines cross at about 120 km/h,⁴¹ which is the minimum total cost. So why don’t we set the speed limit to 120 km/h?

Travel time savings are, while still speculative in terms of their valuation, both private and real. The statistical value of life is far more abstract. The value of my life to me is infinite. The value of your life to me is, sadly, not. Yet, I am willing to take risks that increase the probability of my dying in order to save time or earn more money. These are the kinds of factors that allow an estimate of value of a statistical life.

Death and crashes are probabilistic affairs, while the time lost is deterministic. People are gamblers.

There are some other benefits to faster travel not accounted for, such as more or longer trips (to better destinations, or the ability to get better real estate at the same price), which increase consumer surplus. The analysis here does not consider user response to lower speeds, which would be to travel less. There are also issues like travel time reliability.

Since 1988 The Statistical Value of Life has risen 6-fold in US DOT estimates, the value of time has little more than doubled. If we cut the value of life to \$3 million, (effectively holding the tradeoff more similar to 1988 levels), the tradeoff is much higher.

Speed limits reflect what travelers will travel at, not what we wish they would travel at.

³⁹ US DOT says \$9.6 million (Moran 2016).

⁴⁰ US DOT gives a lot of ranges, but this number is high for all surface travel excluding freight. (Rogoff 2014).

⁴¹ 75 mph.

8

The Solution to Pollution and Greenhouse Gases

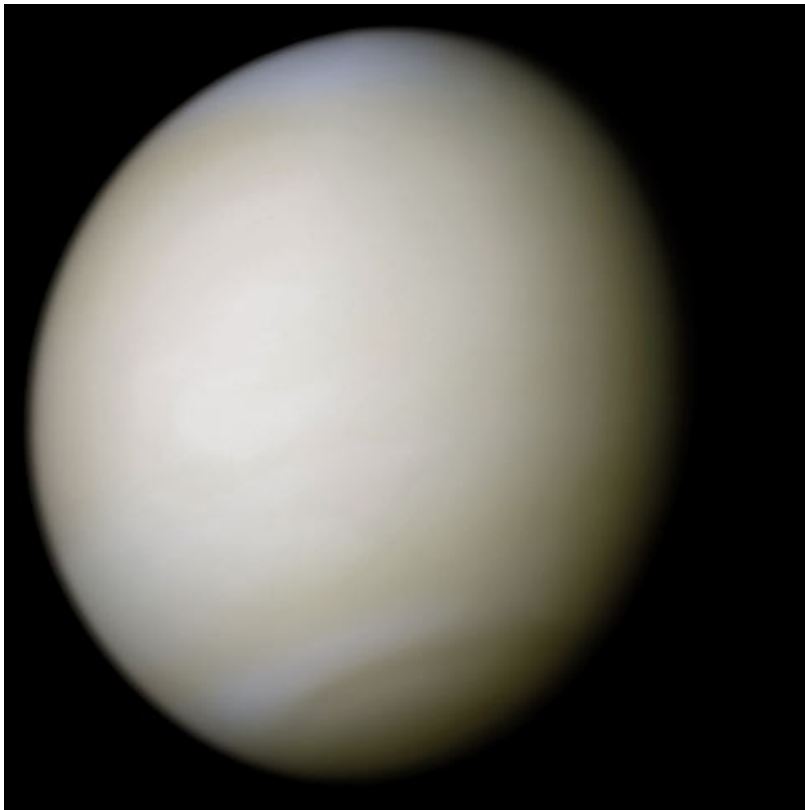


Figure 8.1: Venus. Venus in real colors, processed from clear and blue filtered Mariner 10 images. Source images are in the public domain (NASA). Images processed by Ricardo Nunes, downloaded from http://www.astrosurf.com/nunes/explor/explor_m10.htm. 5 February 1974.

The solution to pollution is dilution – unknown environmental engineer.

Pollution is bad. You would think at this point in human history this observation would no longer need to be made, but

¹ As one example among many, air pollution has been associated with autism (Volk et al. 2013). While correlation does not necessarily imply causation, we believe it's very unlikely future autistic children retroactively persuade their parents to have moved near highways, and it is more likely that the pollution from the highways damages brain development somehow. It is possible, though unlikely, that people who prefer highway adjacency, or who are less annoyed by highways, and thus willing to accept highway adjacency in exchange for lower home prices, are more likely to produce autistic children.

² Some level of pollution may be efficient, for instance when the cost of remediation is very high and the negative impacts relatively low.

³ §7.

⁴ §5.

⁵ §7.6.

⁶ §7.7.

⁷ Global warming is one aspect of climate change. There are others.

⁸ Some people don't accept CO₂ as 'pollution' and prefer 'emissions.' It exceeds the ability of the environment to absorb in the short term, it imposes harmful or dangerous effects, and thus it is pollution, even if it is a natural product. All pollutants are fine in small enough concentrations (hence the opening quote about dilution being the solution to pollution), and everything is horrible in too great amounts.

⁹ Perhaps we might call this 'CO₂gestion'.

governments in several countries are in denial over this basic fact, so apparently are at least some of their voters. For these people, we will quickly summarize the case. From a human health perspective, pollution causes problems and reduces lifespan.¹ It affects most significantly the young, the old, and those with compromised immune systems. Pollutants are breathed in, and smaller pollutants get deeply embedded in the lungs, where they can reduce lung capacity, cause cancers, and are picked up by the blood supply (recall, the lungs are where the circulatory system picks up oxygen, which, while we are not medical doctors, seems to be important for human health) and carried through the body, where they do damage elsewhere, including the brain.

We are certainly not the first to make the case that not all bad things require government intervention. However that doesn't imply the opposite that no bad things require intervention. Pollution is an externality. Those who bear the brunt of pollution are not those who caused it. Polluters are getting a free ride on the expensive health care system and other people's bodies. This is both unfair and as a consequence of not addressing pollution, society gets far more pollution than is economically efficient.²

Other significant technical externalities³ include congestion,⁴ noise,⁵ and crashes.⁶

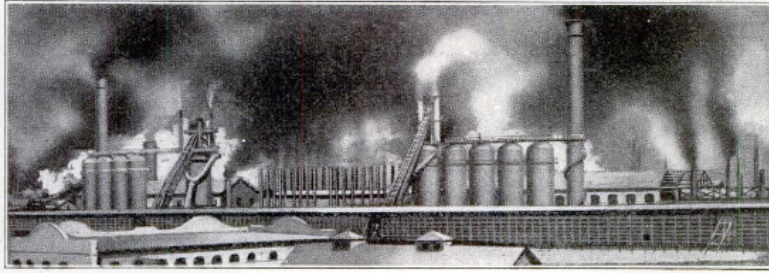
8.1 Global warming

So your planet has global warming.⁷ Venus says "Welcome to our world!" CO₂ pollution⁸ not only destroys the environment and adds to remediation costs, the traditional air pollution that comes with it shortens your life. While this undoubtedly annoys you as a human being, it could be worse; your planet might not have excess carbon dioxide emissions or pollution because no one wants to be there (hello Mars). Still, it would be great to have a thriving planet without pollution. People could do more things over their longer life.

Pollution like congestion can be thought of as a queueing problem. There is a demand side (production of pollution) and a supply side (the ability (capacity) of the environment to process pollutants). When the production of a pollutant exceeds the ability of the environment to process, the pollutant builds up. There is more CO₂ in the atmosphere because humans produce more CO₂ than nature can absorb in the short run. So like traffic in a queue, CO₂ in the atmosphere rises.⁹ This is a straight-forward physical process.

POPULAR MECHANICS

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The furnaces of the world are now burning about 2,000,000,000 tons of coal a year. When this is burned, uniting with oxygen, it adds about 7,000,000,000 tons of carbon dioxide to the atmosphere yearly. This tends to make the air a more effective blanket for the earth and to raise its temperature. The effect may be considerable in a few centuries.

Figure 8.2: “The furnaces of the world are now burning about 2,000,000,000 tons of coal a year. When this is uniting with oxygen, it adds about 7,000,000,000 tons of carbon dioxide to the atmosphere year. This tends to make the air a more effective blanket for the earth and to raise its temperature. The effect may be considerable in a few centuries.” (Molena 1912).

When the CO_2 in the atmosphere rises, the heat of the planet rises with it. This is also a straight-forward physical process, noted by Arrhenius in the 19th century. However, like transport and behavioral systems, environmental systems are complex, so even though the direction is clear, the rate of change is hard to ascertain, and there are many mitigating or exacerbating feedbacks. Still more CO_2 emissions means more heat.

Some of that gets absorbed in trees or the ocean, or is not measured, but the temperature will rise. If the rate of human production of excess CO_2 falls to zero, the excess CO_2 in the atmosphere will eventually be absorbed by nature, the queue will be discharged. But nature will have been changed by the whole process. For as long as we don’t have net zero or net negative carbon emissions, the queue of unabsorbed pollution will continue to lengthen.

There are a number of proffered solutions out there. Pollution is, in principle, a mostly solvable problem, even if no fast-growing planet has, to the best of our knowledge, fully solved it.

This chapter outlines ways that transport-induced pollution could be solved. Some of these are dumb, many are good, one is great.

8.2 Supply-side solutions

Perhaps the most obvious, ‘common sense,’ solution when demand (pollution) is in excess of supply is to expand capacity. This is what we do with most things if we can. If our house is too small, we make it bigger rather than reduce our hoarding. If his wallet can’t hold all of his cash and ID cards,¹⁰ George Costanza might get a bigger one instead of removing useless cards and receipts. If the internet is too

¹⁰ This is a reference to the *Seinfeld* episode ‘The Reverse Peephole’, where George’s wallet ultimately explodes.

slow, we add capacity instead of removing bloated adware. In roads, this usually means adding lanes to existing roads. There are several approaches to address excess CO₂ emissions.

BIO-ENGINEERING. Maybe algae could be added to the oceans, but that sure seems like that would have adverse consequences. Perhaps we could plant more trees to absorb more carbon pollution. Unfortunately, there is not enough space for enough trees to offset the problem.

Consider for instance the Boston to London air travel round trip. It is 5,237 *km* each way¹¹ and 1.1799 *tonnes* of Carbon emissions roundtrip. For \$14.16 or 1,888 Award Miles a United Airlines passenger can support the Alto Mayo Conservation Initiative.¹² Objectively this is not a lot of money in the scheme of things, and maybe it will offset your trip. Nevertheless, we don't have the impression most travelers purchase these indulgences.¹³

More importantly, this does not scale. Some estimates below:

A Trans-Atlantic flight might require 11 trees per person per flight to do a full offset. There are about 100 million international enplanements from the US per year. Not all are Trans-Atlantic of course, many are Trans-Pacific or to South America, and so longer. We will leave it to a research paper to figure out total distance. So that is on the order of 1,100 million trees per year (probably more) to be planted to guiltlessly offset US international air travel.¹⁴ That is 27,500 *km*², or an area of about 165 · 165 *km* on edge per year (for say 50 years until aviation switches to biofuels or electricity). This is the size of Massachusetts.

While that is technically feasible, since the US has lots of land (and is more than fifty times the size of Massachusetts, as Massachusetts is a smaller than average state), no one is actually doing this, and the offset is over the life of the tree, not immediate, so we would need one Massachusetts per year until the end of carbon-emitting aviation to make offsets work.

We could pull out Kant's categorical imperative:

Act only according to that maxim whereby you can, at the same time, will that it should become a universal law.

We might argue that since this doesn't scale (can't become a universal law), you shouldn't do it. But that's the sort of nonsense that we hope philosophers have recovered from.

Just because it can't solve the entire problem and can't become universal doesn't mean it can't be useful to plant more trees. Trees are good. However, while a carbon offset indulgence may absolve

¹¹ 3,255 *mi*.

¹² (United Airlines 2018).

¹³ Catholics have a notion called 'Indulgences,' which in the Middle Ages became a means for wealthy sinners to buy themselves out of eternal punishment for their sins. Alternatively, the loss of wealth might be considered the punishment, if you want to be charitable, which we don't.

¹⁴ Let's assume 5 *m* · 5 *m* per tree (25 *m*²). 25 · 1,100 million = 27,500 million *m*² to offset international aviation from the US (excluding US domestic aviation and travel in other countries).

you from guilt on a particular trip, it cannot absolve the industry, since it cannot scale. Imagine the number of trees required for all aviation, not just international, and for auto travel (about 10x aviation), and not just the United States, but the world. A more serious solution is required, one which either takes CO₂ out of the air more efficiently, produces less CO₂ per flight (through say biofuels or electric power), or reduces the number of CO₂ emitting activities like flights (and internal combustion engine car trips) (by reducing travel).

Now to be clear, if you [expand](#)¹⁵ the capacity of the planet to absorb pollution (i.e. plant more trees), and people pay for their pollution, the reduced cost per unit of pollution means that people will pollute more. Drivers will travel longer, industry will use less socially efficient means for energy generation. There might be a small amount of GDP growth associated with both the geo-engineering and resource extraction, so it is not entirely a bad thing, but it may not solve the overall pollution problem.

¹⁵ §14.

GEO-ENGINEERING. Besides planting trees or algae, perhaps we could do something faster, typically called geo-engineering, using the power of chemistry to capture CO₂ gas or change CO₂ gas into something more benign. There are a number of inter-related approaches to this:¹⁶

¹⁶ This list is drawn from Wikipedia

- Carbon dioxide removal
- Carbon sequestration
- Greenhouse gas removal
- Direct air capture
- Biochar
- Ocean fertilization
- Bio-energy with carbon capture and storage
- Enhanced weathering
- Carbon air capture

The first problem with this set of solutions is that it is potentially expensive. Adding to the ability of the planet to absorb pollution is difficult. People have only done this kind of geo-engineering speculatively. So there is a huge risk associated with some of these techniques, especially the more speculative ocean fertilization. But you know, as they say: “what could go wrong?” For the less expensive methods, the question is whether they can scale to be significant contributors.

SOLAR RADIATION MANAGEMENT. Just deal with the heat, ignore the carbon. Solar radiation management reduces sunlight absorbed

by deflecting sunlight or increasing albedo. This sounds like a terrible idea, but if the CO₂ is bad only because of the rising heat, it could be an interim solution. Volcanoes have similar effects. The problem is cold summers, and one could easily imagine this going badly for crops (and thus humans). Some solar radiation management techniques include:

- Stratospheric particle injection • Cool roof
- Stratospheric sulfur aerosols
- Marine cloud brightening • Space sunshade

8.3 Demand-side solutions

The first set of strategies are basically supply side. But pollution problems are caused by a mismatch of supply (ability to absorb) and demand (production). So let's turn to demand.¹⁷ The main sources of demand are transport, industry, agriculture, and residential, with the electric power sector serving these indirectly. We focus on energy sources first.

¹⁷ The basic equation for emissions in the transport sector is given by the Kaya Identity, rephrased here as:

$$e = p \cdot (v/p) \cdot (l/v) \cdot (c/l) \quad (8.1)$$

where:

- e = emissions,
- p = population,
- v = vehicle kilometers traveled,
- l = liters of fuel,
- c = CO₂ or Other Pollutant (CO, NO_x, SO_x, Pb, VOC, PM10, PM2.5).

If there were fewer people, or they used their cars less or their cars had better fuel economy or the fuel produced less emissions per fuel consumed, there would be less emissions. The last three of these things can be worked on together. The first is behavioral change, the latter will require technological shifts.

¹⁸ This assumes the equipment used to harvest and transport the bio-fuels also use bio-fuels. Like turtles in some Hindu myths, it is biofuels all the way down.

¹⁹ (Tessum et al. 2014).

BIO-FUELS. If all of our fuel were from recently deceased plant matter, rather than oil (long deceased plant matter), and those plants were replanted, net CO₂ from burning fuels would be about zero.¹⁸ The advantage is that the energy density of liquid fuels is generally better than batteries. The disadvantage is the large amount of area needed for bio-fuels, which will compete with food agriculture for the best farmland. Biofuels are likely to be especially important for aviation, which need the range given by high density fuels more than ground transport.

ELECTRIC VEHICLES. If all of our fuel were from electricity, there would be no tailpipe emissions and far less pollution. The cost to pollution would be attributed to the electricity generating sector. If that electricity were from renewable sources, total pollution would approach zero. If it were from burning fossil fuels, the location of the pollution would at least be farther from population centers.

So EVs need to be coupled with renewable energy in the electricity sector to be a net benefit.¹⁹ Electricity is about 1/3 of greenhouse gas emissions in the US. Transformation from burning coal is well underway, and adoption of renewable energy sources like solar, wind, and hydro power, among others, are the best way to get this sector down to zero net CO₂ emissions over the coming

decades. There is a large amount of fixed capacity (sunk costs) out there now, so the transition will take some time.

CONTROLS. Better pollution control devices like the catalytic converter for internal combustion engine vehicles have significantly reduced tailpipe emissions of EPA criteria pollutants.²⁰ Something similar could be done for CO_2 emissions. So the same amount of liters of fuel would somehow produce fewer tons of carbon. The difficulty here is chemistry. The gasoline is ultimately burned, producing CO_2 .

²⁰ EPA criteria pollutants are ground-level ozone, particulate matter, carbon monoxide, lead, sulfur dioxide, and nitrogen dioxide.

Perhaps it could be captured and stored, or catalyzed into some other what we now believe to be innocuous byproduct. Arguably this is a supply side method, but we class it as demand side here as the aim is to reduce the amount of CO_2 emitted, not improve the capacity to deal with emitted CO_2 .

IMPROVE FUEL ECONOMY IN TRANSPORT. Optimization is about making production processes more energy efficient. This is related to conservation, in that it reduces consumption, but at a much bigger and holistic scale, and examines the process by which outcomes are achieved.

Better fuel economy for internal combustion engine vehicles has significantly reduced fuel use, and thus CO_2 , and has plenty of generally good side effects for society, like reduced air pollution and less dependence of oil more generally. Increased energy efficiency overall throughout the economy is feasible.

...

This set of solutions would electrify the automobile fleet, switch the energy source for automobiles from fossil fuels to electricity powered by renewable sources (like solar, wind, hydro, or nuclear) or use fuel cells to transform the number of L/km to zero. However, that is clearly a longer term prospect, fleets and electric generators cannot change overnight. Alternatively, we might work on behavioral aspects of demand, the first part of the equation.

...

REDUCE (OR END) AUTOMOBILE USE. Transport is about $1/3$ of CO_2 pollution, plus or minus. The [chapter on congestion](#),²¹ which this not-coincidentally resembles, outlines how to reduce automobile demand, which is perhaps the largest source of CO_2 pollution. So long as cars continue to rely on the internal combustion engine (in some form for a few more decades yet),

²¹ §5.

²² According to (Dave 2010).



Figure 8.3: Is your journey really necessary? Railway Executive Committee.

reducing automobile demand and gasoline consumption will be critical to reducing CO₂. There are many reasons to reduce automobile use, pollution among them. It turns out, not surprisingly, that biking is more efficient than driving. It turns out, more surprisingly, that eBikes are more efficient than bikes, after netting out the extra energy for the extra food for the extra calories burned biking.²²

SHUT INDUSTRY. Industry is about 1/5 of CO₂ pollution. Perhaps intuitively, if we shut down polluting industries, we reduce pollution. Certainly if we eliminate jobs, we eliminating commuting to those jobs. To the extent we want the thing the industry intends to produce (aside from the pollution), this might be problematic. If we want it closed, but want the goods, the factory will pop up elsewhere with fewer environmental strictures.

EXHORTION. Tell people they shouldn't pollute because it is bad for themselves, or society, or will condemn them in perpetuity to an unpleasant afterlife. Guilt can get you a little bit of benefit, but as evidenced by the state of the world, can only go so far. This is really a means to one of the other ways of actually reducing pollution.

RATIONING. Give people and firms pollution credits, the right to emit a certain amount of CO₂ per year. Reduce that credit annually. Allow them to trade credits for money. If it were cost effective to reduce pollution, they would do so to sell credits. If it were not, they could buy credits. When people talk about 'cap and trade,' that is a form of rationing.

PRICING. Charge people and firms for the amount of pollution they generate and they will generate less pollution.

- How do polluters reduce pollution? This is the best part. Each individual or firm decides for themselves whether or how to consume or pollute less, what production processes to change, when to substitute clean power for dirty. With pricing, polluters will see the air, which is now treated as an unregulated commons as a valuable resource, and if they increase output per unit of carbon, they will save money. They will try to be more efficient about managing the use of the existing clean air.
- Isn't this another tax? This is the second best part. It raises money by discouraging people from doing something that society doesn't want them to do. Other high taxes on things that we want people

to do (like work) can be lowered. Done properly, this is revenue neutral.

- Can this work? This is the third best part. There are many proposed strategies to implement pricing. Obviously this has been politically difficult, or it would already be widespread. Carbon taxes are the simplest intervention, and we already do this in some places (12% of the world's carbon is already taxed).²³ Since it is assessed for industries rather than on individuals, it has a low cost of collection. For instance rather than metering each car, petroleum from refineries or fuel wholesalers can be taxed. This accelerates the uptake of electric vehicles, which should on the net be a good thing.

²³ According to the World Bank's Carbon pricing dashboard ([World Bank 2018](#)).

There are undoubtedly some other solutions out there not discussed here, and lots of details overlooked.

As with [road pricing](#),²⁴ we expect pollution taxes, if not handled with care, will be politically upsetting. There are strategies for dealing with that, we discuss one below. In general, dedicating the revenue to environmental solutions is likely to be more acceptable than putting the funds generated in general revenue. And offsetting other taxes will make pollution charges more acceptable than if they simply increase government funds.²⁵

²⁴ §6.

²⁵ ([Carattini et al. 2017](#)).

8.4 *Pollution trust funds*

If we implement pollution taxes such as Pigouvian taxes, or auctions of pollution credits in a cap-and-trade type system, or fines against large polluters, or with any other mechanism, we will raise revenue that previously was not raised. What to do with the money becomes a question.

Roughly the levy imposed on polluters is proportionate to their pollution.²⁶ Fines above and beyond the base rate would be collected on those who exceed permitted levels with especially dangerous pollution levels.

That revenue should be dedicated to support the US Federal Government's broad collection of agencies that monitor, regulate, protect, and restore the environment, reduce the impacts of humans on the environment, and address the problems that arise when we face environmental emergencies or just dealing with the costs of day-to-day pollution. These agencies include the Environmental Protection Agency, the National Oceanic and Atmospheric Administration, the Federal Emergency Management Agency, and large swaths of the Departments of Agriculture, Interior, and

²⁶ For the purposes here, pollutants are those that contaminate an environment with manmade wastes. Air pollutants include (but are not limited to) EPA criteria pollutants: *Pb*, *SO_x*, *NO_x*, *VOC*, *CO*, *PM10*, *PM2.5*, as well as ultra fine particulates, and *CO₂* and other greenhouse gases. Water and land pollution rules would also be established. Other pollutants as defined by a Blue Ribbon Commission would also be appropriate for taxation.

²⁷ Knittel and Sandler (2011) estimates a gas tax on the order \$1/gal (\$0.25/L) would cover the social costs of carbon from cars, and “reduced air pollution would substantially ameliorate the costs of an increased gasoline tax.” This is substantially lower than fuel taxes in many countries. In the US, current gas taxes vary by state but are on the order of \$0.40-0.50/gal (state + federal) (\$0.10-0.12/L)

Energy among other environmental programs, as well as the Health sector. Estimates of damages from pollution²⁷ are similar in magnitude to the budgets of the listed government agencies.

As pollution diminishes, funding declines, pollution control and remediation programs would shrink naturally, since they are not needed as much. If pollution rises, the revenue increases, giving the government agencies the resources needed to mitigate the effects, redress the damages, and compensate those polluted upon.

A bipartisan Blue Ribbon Commission appointed by the National Academies would be appointed to recommend rates annually based on the best science and economics of the damages that pollution causes (so if avoidance were cheaper than accepting damages it would be undertaken). Any polluter could reduce their taxes by limiting their emissions. Polluters that find reducing emissions cost-effective will do so. The rates would be phased in over a multi-year period to allow smooth and economically efficient transitions.

This proposal lowers expenditures on the discretionary budget from general revenue by pulling the listed agencies off the unified budget. This frees up budget resources that could be used for income tax reform, negative income taxes for people with low incomes, or lowering the budget deficit.

The Environmental Trust Fund, supported by a pollution tax, would incentivize the market to determine the best ways to reduce pollution, rather than relying on government regulations and industrial policies ranging from subsidies and loans to tax credits for favored sectors. Internalizing these negative externalities would reward what we want (pollution reduction) and discourage what we don’t (pollution). This would let individuals and organizations figure out the best ways to reduce pollution. It would also provide opportunities for tax reforms on the general revenue ledger.

8.5 Domain alignment

A key observation is that many of our problems are caused by problem-solution domain mismatch. We often attempt to solve technology problems with policy solutions, and vice versa, as shown in Figure 8.4. The lesson is to focus problems and solutions on the same domain, i.e. policy solutions for policy problems and technical solutions for technical problems. When we get off the diagonal, we get domain mismatch and ineffectiveness. The engineers should rely on the policy-makers to solve policy problems, not offer to do it for them, and similarly, policy makers need to trust the technologists. Identifying the right domain may

		Solution Domain	
		Technology	Policy
Problem Domain	Technology	Catalytic Converters or Electrification to Solve Pollution.	Travel Demand Management to Solve Pollution
	Policy	Capacity Expansion to Solve Peak Congestion	Road Pricing to Solve Peak Congestion

Figure 8.4: The Domains of Policy Problems and Solutions, with Examples.

still be contentious, and there is always overlap, but we hope, once we recognize the issues, we can spot the domain. When we talk about pricing, that is a policy solution, but it is a high level policy solution that induces and aligns lower level policy and technology solutions (demand reduction, system management) for particular problem types (for instance congestion and pollution).

Part II

Network Expansion

The problems of expanding the automobile/highway and public transport systems have become increasingly challenging. As networks enter maturity, expansion is harder and preservation, discussed in the previous part, more necessary. Network expansion is essentially the long-run problem in economics.

9

Hierarchy of Wants

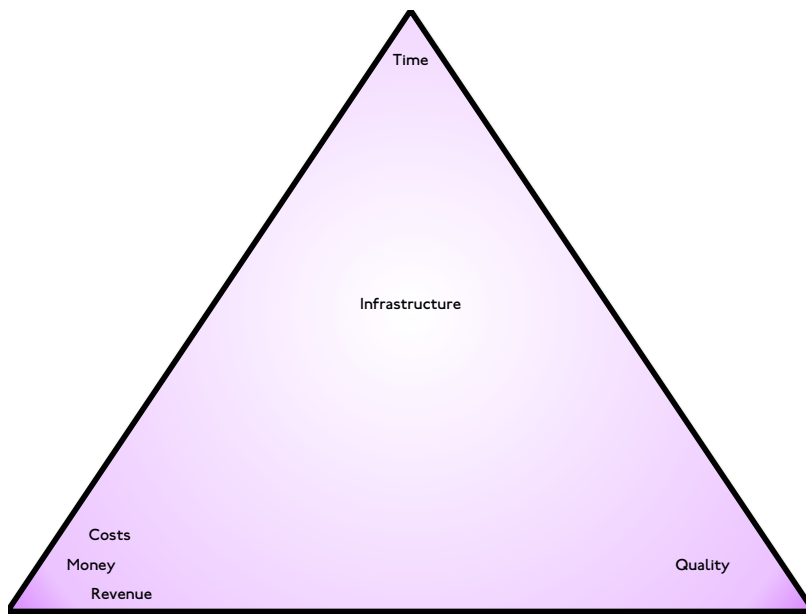


Figure 9.1: The Project Management Triangle: Time, cost, or quality, pick two out of three.

You can't always get what you want
but if you try sometime you find
you get what you need.¹

An earlier chapter described the [Hierarchy of Infrastructure Needs](#).² As self-actualization tops Maslow's Hierarchy, we top our hierarchy with access. And basic access is a need. Society wants not just *basic* access, but *more* access. This is often operationalized as more infrastructure or in some cases as more land development. The problem here is that achieving our wants is getting more difficult.

We want access. We want it to be free. We want it now. We want it to be high quality. Yet, the famous project management triangle

¹From the Rolling Stones song 'You Can't Always Get What You Want.' Jim Erkel calls it the Rolling Stones theory of transport finance.

²§2.

poses a trilemma, it (Figure 9.1) famously says “time, cost, or quality, pick two out of three.”

In transport in the Anglosphere,³ we seem to be getting none of the three. Projects are [expensive](#),⁴ [slow](#),⁵ and [poor quality](#).⁶ Starting in the lower left, we talk about infrastructure costs which are out of sync with revenues. We then discuss the time involved in producing infrastructure, and why it takes so long. This chapter concludes with discussing the quality of infrastructure.

We have a set of funding problems:

- [Wants](#)⁷ exceed readily available resources. The federal gas tax, the dominant source of federal revenue for surface transport, has remained unchanged since 1993. Roads are mostly funded today on a pay-as-you-go basis, which requires current users to pay for projects with long-term value. They are occasionally financed through inefficient municipal bond processes. While states can issue bonds, local governments often find that difficult.
- Wants (new projects) are preferred to needs (maintenance and operations of existing facilities, recapitalizing existing roads). This is referred to as ‘the Ribbon Cutting problem.’⁸
- Needs are not met (especially on local roads which continue to deteriorate in many places).
- [Revenues](#)⁹ from traditional user fees are dropping (due to a combination of peak travel, better fuel economy, and slow electrification of the fleet).

Roads, unlike many network [utilities](#)¹⁰ (electricity, natural gas, telecommunications, some water systems), are currently managed by states and municipalities. Most, if not all, of these other utilities are operated on the basis of a payment-for-use system. Utility pricing varies regionally, some locales vary prices by time-of-day, and users often have the option of choosing different rate plans. These methods manage demand and help match consumer needs with the cost structure of the utility. The public agencies managing roads and transit in the US do none of this, and their culture instead discourages or punishes innovation.

While there are congestion problems in places, there are also many places where roads are overbuilt, what we call [mostly empty syndrome](#).¹¹

Both highways and mass transit cost too much. The reasons for this are many and discussed in [Costs](#).¹²

³ The English speaking counties of the United Kingdom, the US, Canada, Australia, and New Zealand.

⁴ §9.1.

⁵ §9.3.

⁶ §2.

⁷ §9.

⁸ (Taylor 2004).

⁹ §3.

¹⁰ §19.

¹¹ §9.2.

¹² §9.1.

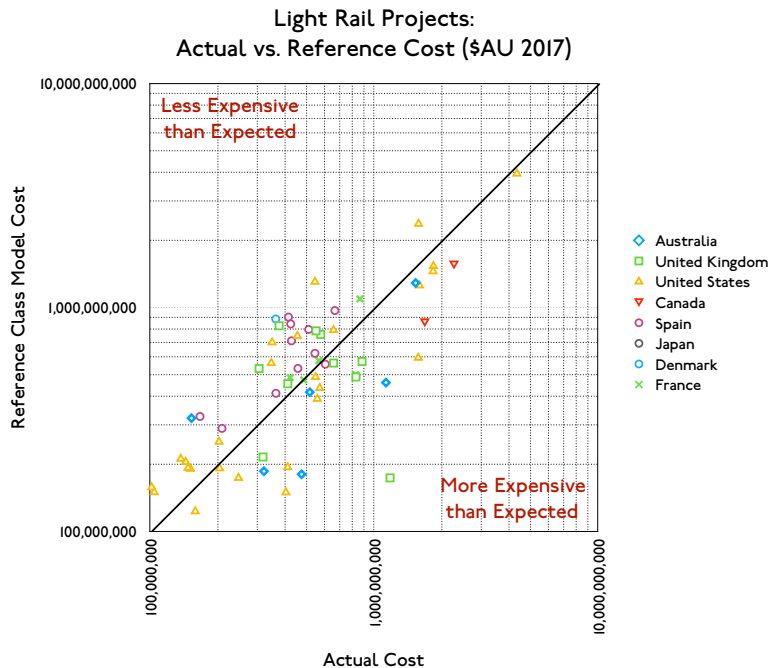


Figure 9.2: Light Rail Projects Cost by Country vs. Reference Model. (Costs converted to 2017 \$AU). Based on Undergraduate Thesis Research at University of Sydney (Stephens 2018).

9.1 *Transport costs too much*

In the 1980s, there was an ad on local TV in the Washington DC region wherein founder Robert Haft, sitting on piles of books, asserted “books cost too much.” Haft created Crown Books, which became at one time the third largest bookstore chain in the US, and helped put independent booksellers out of business decades before Amazon became villain number one among the literati.

Yet unlike independent booksellers, we weep not for the independent contractors and businesses that charge so much for transport infrastructure, equipment, and operations. Consider some costs

- Signalized intersections (\$175,000),¹³
- Roundabouts (\$300,000),¹⁴
- Loop detectors installed (\$5,000),¹⁵
- Diamond interchanges (\$9 million),¹⁶
- Bridge to Houlton, Wisconsin (\$646.8 million),¹⁷
- Buses (\$400,000),¹⁸
- Light rail lines (\$2 billion),¹⁹
- High-speed rail (HSR) lines (\$100 billion),²⁰ etc.

¹³ (City of Palmdale na).

¹⁴ (Office of Safety o o2).

¹⁵ (Office of Highway Policy Information 2007).

¹⁶ (Washington State Department of Transportation 2002).

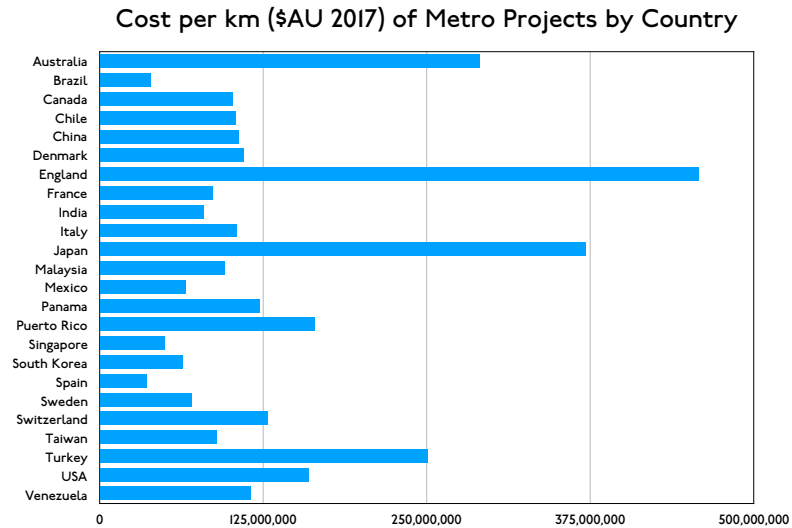
¹⁷ (Divine 2017).

¹⁸ (Clark et al. 2007).

¹⁹ (Metropolitan Council 2018).

²⁰ (Vartabedian 2011).

Figure 9.3: Metro Projects Cost by Country. (\$/km) (Costs converted to 2017 \$AU). Based on Undergraduate Thesis Research at University of Sydney (Xylas 2018).



More formally, we can compare the costs of Light Rail projects (Figure 9.2) and Metros (Figure 9.3) in the US with other countries. The US, while not the costliest in the world, is well above average. The English-speaking countries seem to have a problem.

We are simultaneously spending too much and not spending enough. Because we mis-prioritize where the money is spent, we have inadequate resources for other things. We cut corners.

Why don't we have better bus service operations? In part because the scarce resources that could be devoted to that relatively inexpensive but useful investment are instead spent on expensive new capital investments that serve a much smaller fraction of the population.

We can all think of technically feasible things that we would like the transport system to do, but that it doesn't because resources are scarce. They are scarce because of mis-allocation, not lack of overall spending.

When we are out-of-balance, people distrust that their tax money is wisely spent. If people see many examples of mis-expenditure, they will cut how much they are willing to allocate to transport. This is the credible commitment problem, where the state is not believed when it says what it will do. This is a problem for user fees, such as congestion [system pricing](#),²¹ where mistrust of where the money will go harms public support.²²

²¹ §6.

²² (Manville and King 2013).

Mis-expenditure thus causes the system to deteriorate in two ways. First, it reduces inputs to the system, money that could be spent. Second, it allocates money away from genuine public needs (starting with [system preservation](#),²³ adequate maintenance, and operation of existing facilities) and towards unnecessary wants, thereby increasing unmet needs.

²³ §I.

We need to break this cycle of distrust if we want to adequately fund transport needs (not wants). This requires institutional changes in how transport services are provided. Asking the same people for more money is unlikely to be very successful.

The following sections suggest many possible causes (we might think of them as hypotheses), and to be clear, there is more than one cause, and these causes interact.²⁴ We do not even argue that all of these are necessarily correct, though they are all empirically testable with the right data.

²⁴ Alon Levy discusses a number of these issues in the rail and public transport sectors on his blog pedestrianabobservations.com.

Standards

‘MAN OF SYSTEM’. In his first great book, 1759’s *Theory of Moral Sentiments*, Adam Smith wrote:

The man of system . . . is apt to be very wise in his own conceit; and is often so enamoured with the supposed beauty of his own ideal plan of government, that he cannot suffer the smallest deviation from any part of it. He goes on to establish it completely and in all its parts, without any regard either to the great interests, or to the strong prejudices which may oppose it. He seems to imagine that he can arrange the different members of a great society with as much ease as the hand arranges the different pieces upon a chess-board. He does not consider that the pieces upon the chess-board have no other principle of motion besides that which the hand impresses upon them; but that, in the great chess-board of human society, every single piece has a principle of motion of its own, altogether different from that which the legislature might chuse to impress upon it. If those two principles coincide and act in the same direction, the game of human society will go on easily and harmoniously, and is very likely to be happy and successful. If they are opposite or different, the game will go on miserably, and the society must be at all times in the highest degree of disorder.²⁵

²⁵ (Smith 1759).

STANDARDS HAVE RISEN. Our obsession with safety, features, environmental protection, compliance with the Americans with Disability Act, and quality drive up the cost. Engineering design is often 20% of project costs. If only we would tolerate a few more deaths, a bus without air conditioning, pollution, and frequent

²⁶ Called 'Environmental Impact Report' in some places.

²⁷ See (Todorovich and Schned 2012).



Figure 9.4: Green Line Route Bump.

breakdowns, and facilities that didn't serve anyone with physical challenges, our initial costs would be lower.

But while, as implied sarcastically in the previous sentence, some regulation is useful, it can act like a strait-jacket. The Environmental Impact Statement (EIS)²⁶ leads to 'lock-in' effects where a complete EIS is a determining characteristic of a project's viability rather than some other type of analysis.²⁷

An illustration of this is the Green Line LRT (Figure 9.4) between Minneapolis and Saint Paul. It mostly runs on University Avenue between the cities, but in Minneapolis it switches to Washington Avenue at the University of Minnesota. It was originally designed to go under Washington Avenue, which required some space for a tunnel descent, so was routed slightly north of University Avenue for a few blocks to coordinate this. But to reduce costs, it was rerouted to travel at grade on Washington Avenue. The reroute was no longer necessary, but to change it would have required amending the EIS. Since EISs can take years to complete, having one ready is a big deal.

GOLD-PLATING IS ADDING UNNECESSARY, NEEDLESS, OR USELESS FEATURES TO PROJECTS. The costs of gold plating are several. Money spent on project X cannot be spent on project Y. This is the monetary opportunity cost of misallocation. Land devoted to project X cannot be devoted to project Y. More land also means greater distances to traverse. This is a spatial opportunity cost. There is a tension between the risk of gold plating (focus on benefits to the exclusion of cost) and of corner cutting (focusing on costs to the exclusion of benefits). But there is available to us a balance, building something which maximizes the difference between benefits and costs, not just looking at benefits or costs. Advocates place insufficient attention on the trade-off and too much on the desired outcomes.

DESIGN FOR FORECAST. Designs, rather than responding to the demonstrated needs of today, are responding to an unreliable forecast of future travel demand, assuming behaviors and technologies remain unchanged. While in the early years of technology deployment, forecasts often underestimate demand, as technologies mature, forecasts tend to overestimate demand. Today transport planners also must demonstrate their projects will address potential peak traffic 20 years down the road, when it is assumed congestion will have increased dramatically and no new technologies developed.

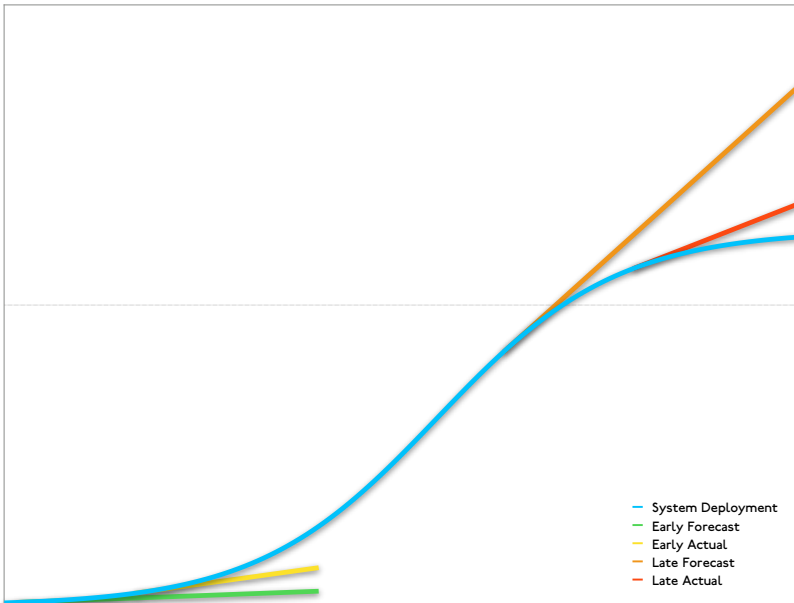


Figure 9.5: Forecast error. In the early part of system deployment, forecasts underestimate growth. In the later, mature stages, forecasts overestimate growth. Source (Garrison and Levinson 2014).

ROAD DESIGN STANDARDS. Funds are collected at the state and federal levels for transport and then a portion of that money is transferred back to local governments for transport. Along with the money comes requirements that dictate how that money is to be used. These include engineering requirements for things such as lane width, degree of road curvature, and design speed and planning requirements for things like maintaining a hierarchical road network. Similarly even local road design standards for firetrucks are problematic. Most US states require cities to comply with the International Fire Code, which insists on streets with a minimum width of 20 *ft*²⁸ and that all traffic calming measures be approved by fire officials.²⁹ Does the firetruck really need to do a 360 degree turn on the cul-de-sac, or can it back out? Should the fire department decide on a bike lane?³⁰

²⁸ Despite being an 'international' fire code, the widths are given in imperial units. 20 *ft* equals 6.096 *m*.

²⁹ See (Snyder et al. 2013).

³⁰ As in this case in Baltimore (Broadwater 2018).

CONSTRUCTION ON FACILITIES STILL IN OPERATION. Aside from the rare bridge, it is unnecessary to keep facilities open and operating while doing construction. This reduces construction space, reducing time, increases set-up/break-down costs, and otherwise adds to total costs. Construction is much faster (and thus cheaper) if rebuilding could be done on a closed facility.³¹ New York's MTA introduced their FastTrack program to close portions of subway lines overnight for a week to speed repairs and cleaning. This was preferred to the

³¹ See the London Underground as the classic example of the high cost of doing construction only at night and weekends, but keeping the line in operation. (Wolmar 2002).

³² (New York Mass Transit Administration 2018).

old system of having workers stop working when a train went by. We can imagine better still.³²

The system as a whole must be reliable, meaning a traveler can get from here to there, but that does not mean every segment must be open 24/7/365. One reason the reconstruction of the I-35W Mississippi River Bridge in Minneapolis was so fast was that they contractors did not need to worry about existing traffic.³³

³³ That it was *design/build*, (§18.2) also reduced construction time.

OPEN GOVERNMENT/COSTS OF DEMOCRACY. The planning process is required by law to bring in as many stakeholders as possible. This has (potentially) led to transport investment being sought and justified for non-transport concerns. Transport investment is now used for social, moral, and economic goals that are not directly related to mobility. Sometimes the costs of democracy are seen through lawsuits. In 2010, San Francisco unveiled a bike master plan for the city. Opponents sued the city on the basis that adding bikes lanes would reduce the vehicular level of service on roads. After four years, and at great expense, the city won the lawsuit and was able to build their bike lane network.³⁴

³⁴ (Goebel and Roth 2010).

UNION WAGES. The Davis-Bacon Act requires contractors on federally funded or assisted projects to pay workers a prevailing wage on public works projects set by the US Labor Department.

UNION WORK RULES. Productivity gains are often made through new technologies. Work rules may prevent new technologies from being deployed.³⁵

³⁵ (Chomitz and Lave 1981; Smith 2013).

BUY AMERICA. Trade protections drive up costs both by reducing competition and reducing competency.³⁶

³⁶ (Platzer and Mallett 2015).

CLIMATE CHANGE ADAPTATION. Designing to be resilient to climate change is adding costs to projects, through better drainage, higher elevations for road beds, and other relatively more environmentally sensitive designs.³⁷

³⁷ (Davenport 2018).

PARALYSIS BY ANALYSIS. The bureaucratic requirement to conduct analysis delays projects and adds costs. Process has been weaponized by project opponents.

Scaling

THERE ARE INSUFFICIENT ECONOMIES OF SCALE. When everything is bespoke, there is no opportunity for standardization and economies of scale. While many rail against cookie-cutter design, it is only with cookie-cutters that we get lots of cookies.

THIN MARKETS. There is no online department store for public works. We cannot go online and buy a transit bus or an interchange. The internet has not driven down prices in this field the way it has in so many others. As a result a few vendors can collude or orchestrate higher prices than would be faced in a more competitive market.

PEAKING. Transport agencies attempt to provide high levels of peak capacity to accommodate the demand that results from un-priced roads and highways. This is very costly capacity to provide. If tolls³⁸ were charged that reflected true costs people would drive less, especially during peak hours. It would therefore cost much less to provide the economically optimal amount of peak system capacity.

³⁸ §6.

MATERIAL SCARCITY. Materials are scarcer than they used to be as more and more are tied up in existing infrastructure, and thus more expensive.

BUILDING BOOMS. Australia's construction boom is driving up costs due to scarcity of labor. Publicly-funded projects are competing with each other for labor, driving up wages, requiring more overtime.

BAUMOL EFFECT. Baumol's cost disease (or the Baumol Effect) produces a rise of salaries in jobs that have experienced no increase of labor productivity, and was first identified for the arts. Since fewer employees are needed in the now more productive industries, the relative labor costs of the unproductive industries rises.³⁹

³⁹ (Baumol and Bowen 1965).

LABOR PRODUCTIVITY. Transit investment isn't realizing any productivity gains from labor. Every dollar spent on public transport yields 70% more jobs than a dollar spent on highways. This is used to bolster the argument that we should spend more on transit, but instead suggests we are much better at building roads than at building transit. As labor is a large proportion of total cost, transit investment has not realized productivity gains that have

occurred in road building. This could be explained in part by lack of competition, low levels of total investment haven't brought new producers into the market, or a number of other reasons. The relatively high number of jobs per dollar spent does not necessarily mean that transit investment is more virtuous. It may just be more inefficient. This is a problem with treating transport investment as industrial policy.

EXPERIENCE AND COMPETENCE. The US has no experience with high-speed rail, so there is no domestic expertise. This is particularly problematic when Buy America provisions are in play, as international firms have to establish domestic operations, or new firms and industries are created. An example of this is the case of United Streetcar, which was created in 2005 and closed in 2015 after delivering only 18 trains.⁴⁰

⁴⁰ (Schmidt 2015).

LACK OF UPFRONT FUNDS. Delays to projects add to ultimate costs. Lack of funds is a scaling or scoping problem, the scale or scope of the project exceeds the financial capacity to pay for it.

Scoping

PROJECTS ARE SCOPED WRONG. We have investments that don't match actual demands. And this is not just for megaprojects. We have big buses serving few passengers. We have overgrown highways. We have a fear of building too small and having congestion or crowding, so we build too big.

PROJECT CREEP. Side-payments in project development crop up. For instance, to placate neighbors, road builders construct noise walls hither and thither. Side-payments are a required part of the politics of getting something built.

SCOPE CREEP. Along the way, even after construction starts, new problems or opportunities are discovered, and the scope of the project changes, leading to expensive change orders.⁴¹

⁴¹ The Sydney City and Southeast Light Rail project had tremendous problems with scope creep, especially regarding utility relocation (Gerathy 2018).

⁴² (King 2016).

'STARCHITECTURE'.⁴² The use of famous architects ('starchitects') drives up the price of projects.

As always though, America must be the exception. Spain would never spend \$3.8 billion on a single starchitect-studded station, but its own Santiago Calatrava was happy to build one if New York was footing the bill. Calatrava's original design called for an enormous bird-like

World Trade Center PATH station whose walls would open up in a sort of flapping motion, but it was scaled back for security and cost reasons. The wings were clipped and evolution was set back a few hundred million years – the bird will now be a ‘slender stegosaurus.’ Even the originally projected \$2.2 billion cost would have been more than Paris spent on its entire new 9 km Metro Line 14.⁴³

⁴³ (Smith 2010).

FRAGMENTED GOVERNANCE. Fragmentation leads to large and meandering projects rather than centralized projects. Politicians have to “share the wealth” of projects. This is perhaps a cause of “project creep.”

UTILITY WORKS ARE UNCHARGED. Utilities have little incentive to minimize the costs and disruptions from moving and upgrading service, and there are far more utilities now than there used to be. Some countries charge utilities rent⁴⁴ for road space when doing subterranean work, which gives them an incentive to coordinate construction projects.

⁴⁴ §4.1.

Principal-agent problems

The principal-agent problem focuses on the different motivations for the ‘principal,’ the individual or group that owns the project, and the ‘agent’ who purportedly represents them, but is typically acting in their own interests.

BENEFITS ARE CONCENTRATED, COSTS ARE DIFFUSE. As a result, the known beneficiaries lobby hard for projects, but not just to build it, but to build it in a way that is expensive. Costs are diffuse, it is seldom worth the taxpayer’s time to oppose a project just because of its costs, which are spread among millions of other taxpayers.⁴⁵

⁴⁵ See *The Logic of Collective Action* (Olson 1965).

PORK-BARREL POLITICS IS THE GREASE THAT LUBRICATES LEGISLATIVE BODIES. Alaska Congressman Don Young famously received campaign funds to lobby for road aid to Florida, the state furthest from his district.

Local officials in Florida are receiving funds for a road they do not want, and are being blackmailed to accepting it with the threat they won’t get other funding. The reason, a local property developer contributed to Congressman Young’s campaign.⁴⁶

⁴⁶ (Kirkpatrick 2007).

And the really strange thing is in the whole scheme of things, they did not give much ... only about \$200,000 for Republicans in exchange for \$91 million in local road projects. Pork barrel

⁴⁷ Eliminating earmarks also made it more difficult to pass federal legislation.

spending has changed substantially in the US since Congress eliminated earmarks in 2011.⁴⁷

⁴⁸ (Hayek 2011).

DECISION-MAKERS ARE REMOTE. Remote actors cannot have precise information about local conditions, and in the absence of a free market in transport (there is generally one buyer, who is generally a government agency), prices are not clear. As a result these remote actors mis-allocate because they are misinformed. This notion derives from the economic calculation problem.⁴⁸

⁴⁹ The term ‘Other people’s money’ was the title of a 1967 play and a 1991 movie based on a 1989 play of the same name. (Sterner 1989; Weidman 1967).

OTHER PEOPLE’S MONEY. Public works agencies are spending ‘Other People’s Money,’ and so are less motivated to get value for dollar than an individual consumer on their own. This principal-agent problem prevails in many organizations, but especially so in public works where the bias is not to have a failure. There was an old saying in business, “No one ever got fired for buying IBM.” The same holds in public works, where rocking the boat with new or innovative technologies is not sufficiently rewarded, and the same mostly reliable contractors are returned to.⁴⁹

⁵⁰ Or the converse, why the feature they don’t want is located in their neighborhood.

ENVY IS A GREEN-EYED MONSTER. Envy is a much bigger problem in public works than in personal life. Taxpayers wonder why Jurisdiction (neighborhood, district) X gets an LRT when their own Jurisdiction (neighborhood, district) Y doesn’t?⁵⁰ It’s a recipe for political hostages at budget time, as few political leaders have any reason to say “You know, the benefit cost on a project in my district just shows the project makes no sense.” It leads to two problems: projects that make no sense to serve some notion of geo-political equity, and project creep because if Jurisdiction X’s light rail stations had public art and golden knobs and a fountain, then district Y’s light rail should have those and more. Combined with the Other People’s Money problem, this type of envy is a recipe for project creep.

PERCENTAGE OF COST REIMBURSEMENT. Planners and engineers are paid as percentage of total project cost, and thus have an incentive to lean toward more expensive designs.

⁵¹ §18.2.

SEPARATION OF DESIGN AND BUILD. Different firms are responsible for engineering and construction, creating high communication costs. We know [design/build](#)⁵¹ saves money, yet this is not standard practice, but instead is considered ‘innovative.’

In addition to driving up costs and dividing responsibility, separating design and build extends construction time.

FORMULA SPENDING. Formula spending reduces the incentive or need to worry much about costs. Formula spending is a process where how much is spent on what is dictated by pre-allocated formulas. This reduces incentives to pay attention to spending.

LACK OF USER FEE FUNDING. Projects funded out of user fees are more likely to be efficient, partly because the agencies or private parties receiving those fees know the fees are limited and partly because they want to spend them in ways that will generate more fees (which means in ways that benefit users enough that the users are willing to pay for them).

CAPITAL-BIAS. Today the US Federal Transit Administration (FTA) disburses money for new local transit projects, which compete for federal dollars.⁵² Because the FTA subsidizes capital rather than operations, transit programs are more capital intensive than optimal. Federal funding programs create perverse incentives that lead to very costly capital projects. Almost any project looks good if somebody else is paying for most of it. For example every year billions of dollars are spent on passenger rail projects that would never be funded were it not for generous Federal grants. These Federal programs, no matter how well intentioned, tip the local decision making process in favor of expensive capital projects and discourage consideration of lower cost options and policy reforms. Projects are also much more expensive because they have to meet complex federal guidelines to qualify for federal funding.

⁵² (Chen 2007).

PUBLIC OWNERSHIP. Most of the transport system is owned, planned, and managed by public agencies. These entities have many objectives but efficiency and cost-effectiveness are rarely a high priority. The public sector does some things well but it doesn't usually do them very efficiently. As a result transport revenues are not always efficiently converted to transport user benefits.

MULTI-JURISDICTION COORDINATION. Because transport involves a large number of public agencies with overlapping or intertwined responsibilities planning is complex and inefficient. Projects end up with all the bells and whistles needed to satisfy the agencies and constituencies that could block a proposal. Local elected officials often load up regional plans with pet projects that do little to

improve transport system performance. There is a whole science to how public agencies bargain with each other and interact, unfortunately the results are rarely optimal from a cost-effectiveness perspective. The principal/agent problem is part of the reason for this, but only a part. In nearly every metropolitan area in the US institutional structure results in transport plans and policies that fall far short of the cost-effectiveness that could be achieved.

GRAFT. Mismanagement and graft add to delays and poor project selection. The highest demand areas for maintenance and new stock occur in places that are expensive. The few suppliers are able to coordinate prices (illegally).⁵³

⁵³ As warned by Adam Smith (Smith 1776). See, for an illustration, price fixing by suppliers in the UK (Rail Technology Magazine 2018).

POOR COMMISSIONING. Contracts determining who does what on a project are poorly written, and affect outsourced projects.

PUBLIC-PRIVATE PARTNERSHIPS. Public-private partnerships trade additional up front costs for faster construction.

LACK OF CONSENSUS. Political requirements for consensus add delays. This is both a standards issue (the standard requires consensus) and a principal/agent problem, the principals or agents do not agree.

STOP/START INVESTMENT. Often caused by budget showdowns or changes of government, projects are wound down and restarted, increasing costs.

RATCHET EFFECT. Interest groups are attracted to a particular public issue and pressure the legislative body to increase spending on that issue, but make it impossible to decrease spending on the issue.

ETHOS, TRAINING, AND PRESTIGE. Transport engineering is more prestigious in other countries. Infrastructure may not attract the best and the brightest any more in the US. The hot industries are those based in California, about how to get stickier ads in front of people reading social network feeds. The kinds of ethos, training, and prestige that go with bureaucratic jobs in Germany, France, Japan, and other countries, are not found in the US.

GOVERNMENT POWER AND LEGAL SYSTEMS. Governments in places with a strong bureaucratic and public works ethos have more power to implement projects, running roughshod over local

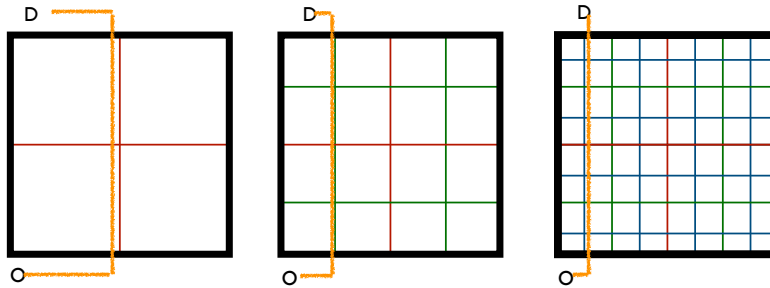


Figure 9.6: Diminishing marginal returns to new roads due to diminishing distance reductions as the network is increasingly complete. Adapted from Figure 25.5 (Garrison and Levinson 2014).

resistance, property claims, special interest complaints, and lawsuits. Some international legal systems are more amenable to construction, including liability, bonds, and insurance.

9.2 *Transport benefits too little*

We are not building much new transport in the US not just because the costs are too high, but because the benefits are too low.

We make the claim that new projects are too expensive, and list a series of hypotheses as to why that might be the case.

When the US was much younger as a nation, say 1956, and growing fast, with relatively poor connectivity, you could do almost anything and it would have a benefit/cost ratio above 1. Very little of the Interstate Highway System has been reversed. But the productivity of new investments has declined over time, as net rates of return are given in Table 9.1.⁵⁴

The 2000s are significantly lower. A value of approximately zero returns in recent years is consistent with recent work.⁵⁵ This is what you expect with life-cycle theory, and it applies well to existing mature modes.

The reason we don't draw new lines on the map is that the net benefits are not perceived to outweigh the net costs. The costs have risen as land has gotten scarcer, and the benefits of additional lines drop.

DIMINISHING MARGINAL RETURNS FROM NETWORK COMPLETENESS. As shown in Figure 9.6, we have diminishing marginal returns to new roads due to diminishing distance reductions as the network is increasingly complete. This is a spatial argument. Imagine you have a network with the historic one-mile⁵⁶ grid originally surveyed as a result of the Northwest Ordinance, typical for much of the midwestern and western US. With

⁵⁴ See also (Boarnet 1997; Iacono and Levinson 2017; 2016).

⁵⁵ (Jiwattanakulpaisarn et al. 2012; Iacono and Levinson 2016).

Table 9.1: Net Rate of Return of Transport Investment. Source (Mamuneas and Nadiri 1996; 2006).

Period	Net Rate of Return
1949-1950	0.554
1960-1969	0.48
1970-1979	0.298
1980-1989	0.212
1990-2000	0.136

⁵⁶ About 1600 m.

development of farms, you add roads in between, say at $1/2$ mile spacing, this reduces travel costs some, as people don't need to back-track as much, and this might be a significant share of the distance for short trips. At most, you are saving someone 1 mile ($1/2$ mile at the beginning of the trip, and $1/2$ mile at the end of the trip). Now add additional links to diminish spacing to $1/4$, This requires twice as many links, but only reduces travel costs by at most $1/4$ mile at each end of the trip ($1/2$ mile total). New links reduce distances less and less. Distances, along with speed, determine travel time.

DIMINISHING SPEED SAVINGS FOR NEW ROADS. Transport links become congested and are thus slower over time due to:

⁵⁷ §14.

- [Induced demand](#),⁵⁷
- Induced development,
- Induced driveways and interchanges, which increase friction on roadways and slow them down over time. While access management addresses this on arterials, very few interchanges are removed to speed freeways, construction is almost irreversible.

Thus we have to discount the opening year forecast travel time benefits to account for the fact that the travel time savings of any expansion will in part (if not in whole) be eaten up by more travel. While this is not of itself a bad (travel is a measure of people doing something that they value), it is not perceived to be a good thing (because it creates congestion and pollution externalities which existing travelers bear).

There is some compensation for induced demand and induced development, as more travelers may lead to more service (induced expansion of existing links and construction of new links), but this is a longer term process, and only works up to a point (and more easily with transit services than roads).

DIMINISHING DEMANDS FOR NEW ROADS. Demand for new roads is decreasing at least on a per capita basis due to peak travel as well slowed population growth, particularly in un-roaded or under-roaded exurban areas.⁵⁸

⁵⁸ (Levinson and Krizek 2018).

This implies the benefits from new construction are falling.

DISILLUSIONMENT WITH THE QUALITY OF TRAVEL AND TRANSPORT FACILITIES. As we note at the outset of the chapter: fast, cheap, or good, pick any two. It sometimes seems we have

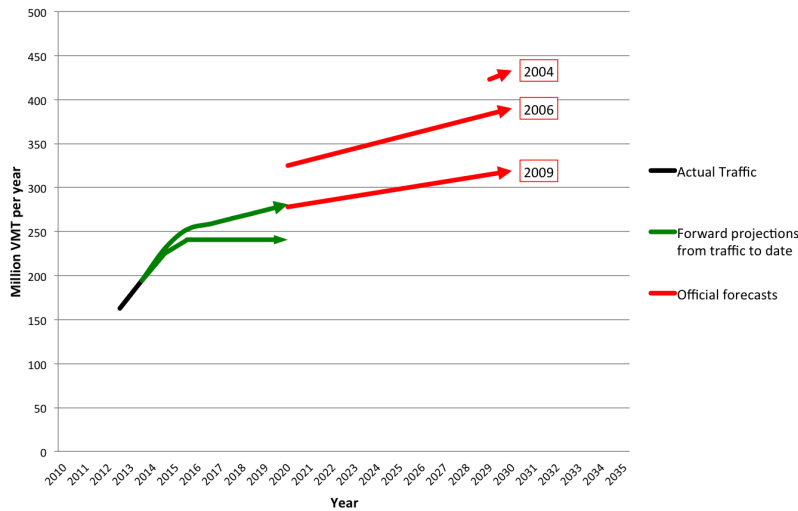


Figure 9.7: Intercounty Connector traffic levels, in vehicle miles traveled per year. Image by Claire Jaffe. Source: (Ross 2015).

none of these. We know transport costs too much. We know transport takes too long to build. Surely if we are paying a premium, it should be of high quality. It seems not. Maybe the few facilities which are brand new, expensive, and took too long to build are high quality, but the rest are not. Even then, we have doubts.⁵⁹

⁵⁹ The Big Dig ceiling collapse was a notable failure, this one all the worse because the facility was new and expensive. (Peterson 2006).

POOR FORECASTING LEADS TO ‘MOSTLY EMPTY SYNDROME.’ If you have been following this book, you may have detected a theme, we don’t like the public wasting money on un-needed infrastructure. Of course no-one endorses ‘wasting’ money, we just disagree what is wasteful and what is an investment.

These are roads and bridges to ‘nowhere,’ or at least to places that few people live, work, shop, or play. We think roads are more widely used than they are, because our perceptions are developed by observing ourselves stuck in traffic. But most roads are empty most of the time. That by itself does not mean they are not valuable, but it does suggest there is a lot of excess capacity in the system. We have many routes that were built by the general public for special interests, routes that drain resources from more important investments, routes that were once important no longer are (because the businesses they served moved away, or the area has depopulated), and routes that were parts of larger projects that never came to be or have not kept up with changing surroundings. New technologies like self-driving cars promise even better capacity utilization, and thus even emptier roads. This longer term ‘problem’ is only a problem if you are in the industry, not for everyone else.

Capacity needs are dropping (due to peak travel, automation (higher throughput, narrower lanes), car sharing, ride sharing, new vehicle types, substitution of telecommunications for transportation). Yet it is politically difficult to address this problem and rationalize the network. The answer is obvious in retrospect. A successful investment had a positive ‘return on investment’ at or above market interest rates. An unsuccessful investment (or waste) had a negative return on investment. Projects with positive but below market rates of return sit in an analytical purgatory.

In prospect, we believe we can assess forecasts accurately, and project advocates are not to be trusted for a variety of well-understood reasons ranging from optimism bias to strategic misrepresentation.⁶⁰ Unfortunately, other people also think they can assess forecasts accurately, even if we know they can’t. If we had better mechanisms for requiring forecasters to be more accurate, we could mitigate these problems.

When these projects are small, it is not terribly important. The analysis of benefits and costs should not be costlier than the benefits from the analysis (i.e. the difference in total welfare from a build/no build or a build this vs. build that decision). But when the project proponents ask for hundreds of millions of dollars (or more), we should be paying more attention.

A large number of projects succumb to ‘mostly empty syndrome.’ MES projects are infrastructure that are underutilized. Mostly they are not underutilized by design, but by mis-forecast. There are facilities however, like NFL stadiums, that are in fact underutilized by design, with numerous marginal events scheduled to mitigate the grossness of the structure.

These are projects that serve purported needs, but those needs don’t materialize. Or they just are insufficient to justify the cost. Or they can be met in a different way. A few examples are listed below:

- St. Paul Union Depot – It is basically slated to serve 350 train passengers a day, and a few buses unless and until many speculative rail lines are opened.⁶¹
- Minnesota’s Northstar Commuter Rail – Some forecasts greatly over-estimated benefits of this line.⁶²
- Maryland’s Inter-County Connector – Failed to realize forecasts of demand, as in Figure 9.7.

There are some counter-examples perhaps, projects that were long considered white elephants, though eventually demand caught up with supply. Dulles Airport meets this criterion. That still does not mean it was a good idea to build it when it was built, even if it is

⁶⁰ (Flyvbjerg 2008).

⁶¹ (Vezner 2015).

⁶² See Section 20.5.

heavily used today. The 20 years of underutilization are fixed capital that could have been better spent in some other way.

There are other counter-examples, projects that were expected to fail (by someone, though not by proponents) that exceeded expectations. The Pennsylvania Turnpike comes to mind.⁶³

⁶³ (Cupper 1990).

What connects MES projects?

- History will show that they are designed and pushed through by politicians serving narrow interests rather than by market demands or public sentiment. That is, they are generated by top-down rather than bottom-up processes.
- They are large and require special treatment.
- They are backward looking, built near, at, or past the maturity of the technology they represent. Air travel was still growing when Dulles was built, and the market grew into its capacity there. Auto travel was still early in its cycle when the Pennsylvania Turnpike was built. In contrast we now have peak travel,⁶⁴ long ago passed peak railway,⁶⁵ and are hopefully at peak football.⁶⁶

⁶⁴ (Millard-Ball and Schipper 2011).

⁶⁵ (Garrison and Levinson 2014).

⁶⁶ (Cowen and Grier 2012).

THE KNOWN BENEFITS OF PRESERVING BUILT INFRASTRUCTURE GENERALLY OUTWEIGH THE BENEFITS OF BUILDING SPECULATIVE NEW INFRASTRUCTURE. The arguments about benefits apply to mature systems in general, and are modally independent. If a new mode comes about that is better than existing modes for some market, it has lots of room to run while providing benefits in excess of costs. But if the new mode is inferior to existing modes, than it has little in the way of prospects.

What constitutes better or inferior is in the eyes of the customer. Certainly customers care about time and price, but they do also consider quality, and may be willing to sacrifice one for the other. But as experience with zeppelins and cruise ships (and conventional intercity rail in most of the US) show, high comfort at slow speed will not defeat low comfort at high speed.

This also has implications for the Preservation vs. Expansion argument: [Fix-it-First](#).⁶⁷ If the old projects had high benefit/cost ratios, and without proper maintenance are at risk of disappearing (either failing catastrophically, or being closed to prevent such an end), it is incumbent to maintain them. In fact, given that land uses and resultant activity patterns that have evolved around transport networks, the benefit/cost ratio (BCR) of preserving those links is probably much higher than it was originally, and certainly higher than the BCR of new links.

⁶⁷ §3.3.

9.3 *Transport takes too long to build*

America entered World War II in December of 1941. By August of 1945, three and a half years later, the war was over. While it is easier to destroy than create, think about all that had to be created to destroy so efficiently. The Inter-County Connector opened in Maryland in 2011, the environmental review took 27 years.⁶⁸ Plans for it dated to the 1950s, and the alignment to the 1960s. It now takes longer to build a suburban toll road than up-end the world order. There is something absurd about that.

In 2015, David Levinson had dinner with Fred Salvucci, former Massachusetts Secretary of Transportation, obstetrician to the Big Dig, and now at MIT, while both were in Santiago, Chile. Among other topics, he talked about complaints about environmental regulation. Critics will complain about environmental regulations, which are used as cudgels by political opponents of the project (including environmentalists, of course).⁶⁹ Fred made a point any queueing theorist could appreciate. He argued that environment regulations are not slowing down transport projects as a whole. There is only so much federal (and state) funding, and that is the real bottleneck. Loosening environmental regulations will not make any more projects get built in any given year.

He adds:

A further concern that I have is that many DOTs are most concerned with maximizing construction volume, so are likely tempted to skew their candidate projects towards the simpler to get through the environmental process. These projects may actually be the least important ones to actually implement, so there is likely a perverse outcome in terms of project portfolio.

Of course it may affect the sequence of projects, projects with more environmental problems, or more social impacts which induce well-heeled people to use environmental regulations as a roadblock, may get deferred for simpler projects without such problems. But shouldn't they in a functioning democracy?

If environmental costs are real, and we think they are, that should make projects more expensive in order to ameliorate such costs, either through avoidance of creating the damages in the first place, or compensating the losers. This higher costs reduces the number of projects that can be done with the money. So it goes. All the low hanging fruit was eaten years ago.

If those projects still pass a benefit / cost test after amelioration, then sure, build them. That is of course less likely than if transport investments [export environmental costs](#)⁷⁰ to the health sector or

⁶⁸ (Plotch 2015).

⁶⁹ See also (McArdle 2019).

⁷⁰ §7.

agriculture, or property values, or anywhere else that it is not properly accounted for.

RECOMMENDED BENEFIT/COST ANALYSIS PROCEDURE.

- All highway, transit, airport, and port projects that are considered in project-selection processes involving expenditure of state or federal funds above \$5 million shall undergo a consistent, peer-reviewed, monetized benefit/cost analysis that would:
 - Consider the full benefits and full costs of the project (in comparison with a no-build alternative) incorporating changes in: number of passengers and amount of freight, travel time and travel time reliability, accessibility to employment and workforce, land value, wider economic benefits, crashes and crash severity, air, water, land, noise, pollution costs, and carbon emissions, public health (including both physical activity and pollution levels), vehicle operating costs, as well as the costs of building, maintaining, and operating the project over time.
 - Consider these costs and benefits distinctly for the population as a whole as well as any relevant transportation disadvantaged groups
 - Consider these costs and benefits not only for the project, but for the relevant portion of the transportation network, including related transportation sections both upstream and downstream of the project and competing with the project.
 - Consider uncertainty bounds in the estimation
- These analyses must be performed according to a standard methodology published by the Department of Transportation (DOT).
- The methodology and analyses shall be reviewed every two years by a national panel of transport and economics experts convened by DOT.
- The results of these analyses, including both the final results as well as the component estimations, shall be made public and posted on the DOT website in a readily accessible manner. An Annual Report of considered and selected projects shall be provided with the full benefits and full costs reported, and justification provided for any projects that were selected over other projects with higher expected benefit/cost ratios.
- In order to improve travel and cost forecasting, and provide an understanding of the accuracy of such forecasts:
 - The project-delivering agency shall review project cost estimates made at the time the project was approved for construction upon completion of the project, and report to the Legislature a table of expected and actual cost expenditures for all projects.
 - The agency shall review travel demand estimates made at the time the project was approved for construction 5, 10, and 20 years after completion of the project and report to the Legislature a table of expected travel and actual travel for all projects.

9.4 *Benefit/cost analysis*

The problems identified above are in part due to misassessment of benefits and costs, partly due to lack of cost and benefit and quality controls, and partly due to no relative assessment of benefits and costs.

⁷¹ (Richards 2011). Heminger was hired in 1993 and appointed executive director in 2001, and only by 2011 do they value doing benefit/cost analysis. He left in 2018 (Vallejo Times Herald 2018). Examining the ratios presented in the story, despite it being a textbook procedure, they are clearly doing it wrong. But it is progress to at least acknowledge using B/C analysis even if the implementation is flawed.

AGENCIES SHOULD CONDUCT BENEFIT/COST ANALYSIS. A recent headline in the *San Jose Mercury News* says: “Bay Area transport projects to be judged on benefits vs. costs.”⁷¹

“Talk to any business person about not having a benefits vs. cost discussion and they’ll say, ‘Duh, you mean you don’t do that?’ ” said the commission’s executive director, Steve Heminger. “They insist on it, but in the transport profession it is not all that common... This levels the playing field.”

Because benefit/cost analysis is only as good as the integrity of the data and the analysts, measuring benefits and costs can be tricky. But it is not impossible to get a first order estimate, and the general principle is straight-forward. Sadly almost no agency requires actual benefit/cost analysis. We would suggest rules something like shown in the box.

9.5 *Big infrastructure*

In his 1996 State of the Union Address, then President Clinton said twice “The era of big government is over.”⁷² Clearly it was not. While government spending ebbs and flows, big government continues to be a feature of American society.

Our Presidential Administration would claim the “Era of big (civil) infrastructure is over” in the US. Not that we don’t have big infrastructure, we do, and it isn’t going anywhere soon. The size of the paved area in the US is on the order of the State of Virginia.⁷³ That’s pretty big, and just looks at one measure of one infrastructure (admittedly a large one).

Once upon a time we did deploy big infrastructure. The railroads in the 19th century, and the Interstate in the 20th were BIG. Turnpikes and canals were other large technical systems of the 19th century, as were the US Highway system, airports, container ports, and the like in the 20th. But they have been deployed, and many of them are already shrinking.

Instead, because the existing infrastructure systems are mature (built out), they need little expanding (and likely some contracting).

Certainly there are potential new infrastructure projects for surface transport. The most widely discussed would be intercity [high-speed rail](#)⁷⁴ and urban transit projects. Similarly there are proposals for [water](#)⁷⁵ (rebuilding the water and sewer networks) and for energy (massive investment in renewables as well as smart grid technologies). We think the transport investments are unlikely, the water investments are mostly piecemeal replacements, and the energy investments will be a set of many small, decentralized power

⁷² (Wikipedia contributors 2017).

⁷³ (Peters 2015).

⁷⁴ §15.

⁷⁵ §2.4.

generators rather than large facilities. In short, change is likely to incremental rather than comprehensive.

In part the question turns on what you mean by 'Big,' and we think we mean system level deployments, like the Interstate, or a national high-speed rail network, and not individual segments that are adding to an existing system or replacing an existing system element in-kind with some added functionality.

On the transport side, there is little interest in large new systems. The last great window for high-speed rail was the 2009 Recovery Act, which did not achieve that aim. As of this writing a decade later there is no actual high-speed service to show for it. Even if the California line were ever opened, we are decades away at the earliest from the onset of a national network in the US.⁷⁶

Proposals for new Interstates appear from time to time, like one for a proposed I-87,⁷⁷ and occasionally one actually opens, and even a second or rejuvenated Interstate 2.0 system has been proposed, but again there is no strong push for such a thing, and the advent of new technologies gives such proposals a ghost-like feel.

There are new systems emerging. The internet and wireless telecommunications are pretty important. Combine these with transport and we can construct an on-call ride-hailing system that has updated the traditional taxis. This may eventually become substantial with autonomous vehicles. But this latter element is not a conventional physical infrastructure investment (not much of one, some servers, some software), rather it redeploys existing (and soon new) vehicles in a useful way.

The new information-enabled systems that ride on-top of the classic physical layers are the products of electrical engineers and computer scientists, not great civil engineering works. We can imagine some things that might become useful. For instance we can think of space civil engineering, things like space elevators and Dyson Spheres. But these are not on the near horizon.

Unless we can find an infrastructure that increases connectivity massively the way the railroad and the Interstate did (doubling speeds), there is no point in spending resources for that given the increasingly high costs and diminishing returns that civil infrastructure faces. We have enough trouble maintaining what we have with its proven connectivity (or lack thereof), the value of future infrastructure systems is speculative at best.

⁷⁶ While construction continues on some segments of the California HSR line, the overall project still lacks needed land and committed funding, and has been put on the back-burner. California officials continue to plan on federal funding for large portions of the total cost, despite no federal interest in providing any since the 2009 Act.

⁷⁷ 10 points if you knew that was Norfolk to Raleigh without looking it up .

10

Macroeconomics: Is Transport Stimulating?



Figure 10.1: Civilian Conservation Corps (1933). Source: National Archives and Records Administration. Franklin D. Roosevelt Library (NLFDR).

On December 6, 2008, in the throes of the Global Financial Crisis, then President-elect Barack Obama laid out key parts of Economic Recovery Plan.¹ In his radio address he boldly said:

... [W]e will create millions of jobs by making the single largest new investment in our national infrastructure since the creation of the federal highway system in the 1950s. ... If a state doesn't act quickly to invest in roads and bridges in their communities, they'll lose the money.²

¹ This chapter is based on a piece originally written for the Van Alen Institute (Levinson 2017).

² (Wallsten 2008).

This plan turned into the American Recovery and Reinvestment Act, (ARRA) with a total budget of \$831 billion. It dedicated \$105 billion to infrastructure, of which \$48 billion went to transport. Of that \$27.5 billion went to highway and bridge construction projects, a surprisingly small share, about 3.3%.³

³ (Wikipedia contributors 2018b).

How many jobs were actually created remains unclear. While that spending directly hired some number of people, some of those people would have been otherwise employed doing something else, perhaps at a lower salary. Macroeconomic theory suggests those who were directly hired would subsequently spend money, resulting in more economic activity, and more jobs.

This is considered a multiplier effect. The Congressional Budget Office (2010) estimates that every dollar spent on Transfer Payments to State and Local Governments for Infrastructure results in GDP growth of between 1.0 to 2.5 dollars, which is higher than tax cuts or transfers for other purposes.⁴

⁴ (Congressional Budget Office 2010).

While claims of jobs that would be created varied widely (from 10,853 'job-years' to 34,799 'jobs' per billion dollars spent (implying 300,000 to 1 million jobs or job-years) the actual amount is unknown. Though there may be some hope of knowing the number of people actually employed, there is no hope of knowing the increase in direct employment (as some of those workers might have done something else). Also no one actually knows the number of indirect jobs created.

⁵ (Anderson 2008).

For instance, the Star-Tribune⁵ at the time of the ARRA reported on a study by the Federal Highway Administration which estimated that for every \$1 billion spent on transportation projects, a very precise 34,799 jobs are created. The source of this cannot be verified, but it may be a typo and a misunderstanding of a study discussed below which showed 34,779 jobs for every \$1.25 billion spent, the difference in \$1.25 and \$1 billion is probably a function of the 20% match that states are supposed to provide. In any case, if that had held up, the \$27.5 billion federal dollars on infrastructure would have generated over 950,000 jobs.

The Minnesota Department of Transportation, citing what we believe is the same FHWA study, but looking at direct jobs (jobs actually created in the program) and indirect jobs (jobs of suppliers for project materials) but not 'induced' jobs (the result of additional spending on the economy) was a bit more humble, only claiming that for every \$1 billion spent, 27,000 jobs could be directly and indirectly created, and then downscaled that to half as many.⁶ The President's Council of Economic Advisors subsequently estimated that each \$1 billion created 10,853 job-years.⁷ The Grow America Act promotion material claims "Every \$1 billion in public

⁶ (Zdechlik 2009).

⁷ (President's Council of Economic Advisors 2009).

infrastructure spending creates 13,000 jobs.”⁸ a number that had previously been used for the proposed American Jobs Act.⁹

Leduc and Wilson (2013) found that in the 1993-2010 sample period, highway spending shocks boost state GDP but not employment. However during the Great Recession, highway shocks had a large short-run impact on GDP, likely due to the large economic slack (unemployment). Leigh and Neill (2011) find highway grants reduce local unemployment in Australia.

Across the US, as of 2017, about 337,000 Americans work in highway, street, or bridge construction, some 222,000 in construction trades.¹⁰ This number has been higher in the past, 360,000 as recently as 2006, so there may be some reserve labor pool, possibly unemployed or employed elsewhere, to draw from. Nevertheless, any stimulus designed to increase employment in this sector is drawing from a limited pool if the skills of the workforce are to be recognized.¹¹

Most of these jobs are skilled, requiring two or three years of apprenticeship and on-the-job training.¹² So while stimulus may be able to directly employ otherwise unemployed people with training in this field, it is unlikely to be able to provide much useful work for unemployed people from outside the sector, at least not immediately.

In macro-economic terms, jobs that employ people who would otherwise be unemployed are a short-term benefit; in micro-economic terms, jobs are a cost. If one company proposed to build a small bridge and said it would cost \$1,000,000 and employ ten people and another said it would cost \$500,000 and employ five people, the state would do the latter. To maximize the amount of infrastructure society gets per dollar, the government needs to be efficient about how infrastructure money is spent. From an infrastructure perspective, if a road project employs some people, that provides a nice rhetorical flourish; but if projects are aimed solely to employ people, the state will be wasting money which in the long run shrinks the economy. The debt borrowed to build projects ultimately comes due.

Highways are much more capital intensive than they were in the 1930s, using heavy machinery and many fewer workers. Macro-economists or policy-makers who think of highways as huge job-creators are simply remembering grainy black and white films of the Civilian Conservation Corps showing gangs of workers with pickaxes digging ditches and building roads through national parks, as illustrated in Figure 10.1. This of course doesn't mean

⁸ (US Department of Transportation 2014).

⁹ Zhang et al. (2016) summarize the literature:

Federal Highway Administration (FHWA) created an input-output economic model called JobMod with the Boston University Center for Transportation studies in 1997 to estimate the employment impact of highway infrastructure investment. The 2007 estimates show that a total of 34,779 long-term jobs would be supported for every \$1.25 billion spent in highway capital investment. Of those 34,779 jobs, around 35% come from construction-oriented sectors and 15% come from supporting industries. The remaining 50% is induced employment. Some researchers found that public investment had a positive effect on employment; (Flores de Frutos et al. 1998; Pereira et al. 2007) others argued that the impact of public investment on employment was insignificant. More particularly, Kamps (2005) explored the relation between public capital, output and employment in OECD countries, finding that there was little statistical evidence that public capital can yield job growth. In the same direction, Jiwattanakulpaisarn et al. (2009) employed dynamic panel data models to study the relation between highway infrastructure and county-level employment for the state of North Carolina. Their findings were similar to Kamps (2005)'s, suggesting that, as the model specification gets more accurate, the magnitude of the impact of highway investment on employment becomes negligible.

¹⁰ (US Bureau of Labor Statistics 2018).

¹¹ (US Bureau of Labor Statistics 2016). This job difference is a drop-in-the-bucket in an economy that in a normal expansion creates about 200,000 jobs every month (US Bureau of Labor Statistics 2017).

¹² (Sherk 2013).

roads should or should not be built, but the stimulus bill was not terribly effective in this arena for job creation.

The value of the projects from stimulus is also questionable. In order to be viable for receiving stimulus funds to put people back to work, they had to be 'shovel-ready' and not underway. But these were projects that were already designed and had environmental permits yet were not built, and so not priorities of the transport agency.

Transport should be justifiable on its own merits (private plus social benefits exceed private plus social costs), not because it creates jobs. A recession may however make the case stronger. If a recession causes employment to fall (and thus wages to drop, and other demand to drop, so other capital costs to drop as well), the total costs of a project will drop, and the ratio of benefits to costs should rise. The benefits may be lower due to lower initial demand, but that is only short-term and thus a small fraction of the benefits, while the cost drop due to less expensive construction is a large fraction of the costs. If the benefit/cost ratio rises, funding is more justifiable.

More to the point, it is ideal to run the capital equipment required for road construction at a continuous level of full utilization, because this equipment is expensive, you don't want it lying about unproductive, and you don't want to buy more for only a short-term spike. Due to specialization, you cannot effectively use much road construction equipment on non-road projects. Continuous utilization is achieved by a steady rate of expenditure on projects which is neither spiky due to stimulus or other money bombs, nor on the other side, vulnerable to drops in revenue due to failure to authorize expenditures, short term drops in user fees, etc.

Before the 2016 election, advisors to Donald Trump put out an infrastructure proposal that would give some \$137 billion in federal tax credits for private financing of infrastructure. More recently, the Trump administration proposed to spend \$1 trillion on infrastructure, through various tax incentives, (notably, not \$1 trillion of direct government spending). The proposal is a bit of a shell game because the assumption is that the federal government will provide tax credits to these private companies who will then raise money and build infrastructure. The claim is the tax credits will be offset by greater revenue that comes into the federal treasury because of income tax, because there are workers now who are working on this newly funded infrastructure who otherwise would not have been. The claims are dubious and disingenuous in a full

employment economy because these resources would otherwise be used elsewhere.¹³

Under full employment, if the workers weren't working on one particular road, they'd be working on a different road. There would be profits from that different road, and there would be income taxes from those workers, all of which would come into the federal treasury anyway. Reallocating jobs from one project to another likely has no stimulus effect, though it could easily add to the deficit if workers are shifted from one project to another and the tax credits are not repaid with higher income tax revenue.

Were the economy in recession or depression and the workers otherwise idle and unemployed, such as in the depths of a recession, and then stimulus employs them, infrastructure investment for macro-economic purposes (i.e. Keynesian stimulus) might be warranted. Taxes would be paid by workers who would otherwise not be earning income. But stimulating the economy when the unemployment rate is 4.9%, as at the end of President Obama's Administration, is very different than doing a stimulus when the unemployment rate is 11%, as at the outset of that Administration.

So while the creation of jobs from infrastructure construction is limited, there are potential long-term benefits of constructed infrastructure in terms of jobs. Again it depends on context. Economic activity increases with accessibility, the ability for workers to reach jobs and for firms to easily interact. In principle, one way to improve accessibility is make it easier to traverse long distances in less time, so you can reach a larger number of jobs (vendors, customers, and so on) in a given travel time. This occurs with faster and more direct transport.

However, the existing surface system (buses, rail, highways) is mature. It is not just old, though it is that too, it also already connects all the places worth connecting as fast as can be cost-effectively connected in most parts of the US. It will not cease to be mature by throwing lots of dollars into new facilities, (no realistic amount of new facilities will obviate the existing system) but will slowly become senile (and yes, literally, collapse) if it isn't properly monitored and maintained. It is not sexy, it will not cut more ribbons, but it is necessary to rebuild what exists.

When politicians like to talk about jobs programs, they evoke the job losses in the coal mines and rust belt industries. And certainly there are problems in those regions. Yet, the areas of need of new infrastructure are in larger cities and in areas that are doing economically very well, while the areas of excess labor are in other

¹³ In early 2019, when this was written, the unemployment rate for the US was 4%, which is considered full employment.

parts of the country. Do those prospective workers want to relocate? It might not be cost-effective personally for them to do that because living in the big city is a lot more expensive than living in a rural area. It may be difficult given their families and social networks are embedded in place. There are also skills required. Construction is not unskilled work. It might not require a college degree, but there are many skills required in building a road properly understood by the workers who have gained experience over time building roads. And the people who build roads differ from the people who build homes, railroads, storm sewers, and water pipelines, or who dig mines.

Road construction is capital-intensive. What once might have taken a hundred men with a shovel, now takes one construction worker with a large piece of construction equipment to move dirt. The mental models held by politicians and economists of building infrastructure formed from the 1930s in the Great Depression, and fail in a world where we have automation, and we require many fewer people to build the same length of road as we once did.

Infrastructure and jobs policy should be two separate things. The best infrastructure plan does not necessarily align with best plan to create new jobs. Instead, we might think about jobs programs in other fields, jobs that require a lot of person-to-person interaction.

Two Nobel Prize winning economists have suggested some rules about managing economic policy:

- Jan Tinbergen's rule: Achieving a multiple number of independent policy targets requires an equal number of policy instruments.
- Robert Mundell's rule: Each policy instrument should be assigned to a policy target on which it has greatest relative effect.

Following Tinbergen, jobs are one policy target, infrastructure is another. Each requires its own instrument.

This book tends to abide those rules. There are occasions, like road pricing, which both manages traffic and raises revenue, where there are instruments that kill two birds with one stone, but infrastructure and jobs is not a good example.

The Magic of Streetcars, the Logic of Buses



(a) Washington Avenue 1954 (last run of Streetcar).



(b) Washington Avenue 2014 (Green Line LRT, Photo by D. Levinson).

Once upon a time (1888 to be precise), the United States and the world launched a huge building boom for urban streetcars. Companies like Twin City Rapid Transit laid miles of track in fast-growing cities, extending well past the built areas to serve greenfield sites for emerging suburbs waiting to be platted and built. They did this because the streetcar promoters benefited directly from the land sales. The availability of a new, fast transit system connecting to downtown made houses much more valuable. The fares from the new passengers covered the operating costs of the system.

Streetcars were financed by a mechanism we now call [value capture](#),¹ Joint development was quite common in the railroad and

Figure 11.1: These images from Coffman Union show the main Mall of the University of Minnesota campus over a period of 60 years.

¹ §16, but is more accurately called joint development.

streetcar eras. As part of grants of rights-of-way to the transcontinental railroad in the United States, large grants of land were given to help the railroad pay for the infrastructure they were creating. In an urban context, private transit companies were often developers of ‘streetcar suburbs.’² This occurred in the Twin Cities in the late 19th and early 20th centuries, where large parts of what are Minneapolis and Saint Paul were built around that era’s dominant transport technology. Evidence shows that the streetcars led development in the Twin Cities (though in other places, transport may lead or follow development).³ This growth is illustrated in Figure 11.3.

² See the book *Streetcar Suburbs* by Warner (1978).

³ See Levinson (2008); Xie and Levinson (2009); King (2011).

Though it was used widely in the past, there is a lesson to be learned from the deployment. Joint development was critical in paying for the initial capital costs of the streetcars.

Networks continued to grow until the 1920s and 1930s, when the bloom came off the boom. The new motor car served the prospective suburbanite just a bit better than the sluggish streetcar. However over time infrastructure needs replacement. By 1950, the streetcars were upward of 60 years old and needed a major infusion of capital to be maintained. Instead, they were abandoned *en masse* across the United States for buses in a process that in the transport field has been termed ‘bustitution.’ Unfortunately, the initial source of funds, the cross-subsidy from real estate, was no longer available, as the real estate was already developed. The owners of the streetcars in Minnesota, still private, like many others across the world, chose to convert to buses – ‘free-riding’ on public roads required much lower capital outlays than reconstructing and maintaining tracks.

It may be too much to expect the initial streetcar developers from the 1880s to have planned for replacement in the 1950s, but should it be desirable to maintain infrastructure over a long period, a continuing source of revenue that pays not just for operations, but also accrues revenues ultimately for periodic reconstruction, must be identified.

The causes of the decline of the streetcar remain a sore point with urbanists, but this was a global phenomenon that happened in any country rich enough to see mass motorization defeat mass transit. The US transit crisis⁴ – a collapse of demand and thus revenue beginning shortly after the peak of transit demand during the rationing of fuel and rubber during World War II – affected not only streetcars, but also commuter trains and urban subways.

In response, the US federal government began funding large transit capital projects starting in 1964 through the newly created Urban Mass Transit Administration (UMTA). UMTA helped with

⁴ §4.3.



Figure 11.2: McKinney Avenue Transit Authority, Dallas, Texas.

the municipal takeover of transit, and then provided capital for expansion in the 1970s. It's worth noting that there was more experimentation in this period than at present – the Peoplemovers installed in Detroit and Miami came from this period, as did funding systems like the San Francisco region's Bay Area Rapid Transit (BART), Washington, D.C.'s Metrorail, and Atlanta's Metropolitan Atlanta Rapid Transit Authority (MARTA). Beginning in the 1980s, the underwhelming performance of this new generation of heavy rail – especially systems like those in Baltimore and Miami – led the federal government to support, instead, streetcars, newly rebranded as light rail transit (LRT) systems.

This new generation of rail, including San Diego's Tijuana Trolley and the Portland MAX, differed from traditional streetcars in subtle ways; even professionals have difficulty differentiating the two. In general, the LRTs are wider and longer than the streetcars of a century ago and their more recent reboot. More important, LRTs tend to run in exclusive, but not grade-separated rights-of-way. With federal matching dollars being just given away, cities bid for new light rail systems, and many were constructed.

The modern streetcar was born when local governments balked at running LRT vehicles down city streets because it took away too much right-of-way from cars. The solution was to make a narrower, shorter vehicle that harkened back to historic streetcar proportions – although often modernized with low-floor boarding to comply with requirements of the Americans with Disabilities Act, among other amenities – and that could run in the street right-of-way.

Running in traffic has major downsides. A streetcar, unlike LRT in an exclusive right-of-way, cannot pass cars; it too gets stuck in traffic. In fact, because it is tracked, it is more likely to be stuck in traffic than a bus, which can change lanes. As any rider of legacy systems can tell you, streetcars are no faster than buses, and in many circumstances no faster than walking.⁵ Average streetcar operating speeds range from 7.1 km/h⁶ in Little Rock to 12.4 km/h⁷ in Tacoma. Tellingly, streetcars have been embraced by the ‘slow transport’ movement.⁸

Portland, Oregon is one of the major battlegrounds in the mode wars (bike vs. car vs. transit and the internecine rail vs. bus). Since the 1980s, Portland has been held up by planners as the exemplar American city that does almost everything right. The foremost thing they do right in the view of the planning establishment is promoting LRT and bicycling.

Portland opened a modern streetcar system in 2001. Along with introducing the streetcar, the city changed zoning and other development regulations, and the development machine took off. The zoning could have been implemented in the absence of the transit investment, but often rail justifies change.

This Portland example, excellently marketed, has been promoted in city after city as the latest urban elixir, both absolving the city of all its sins and growing city development muscles to Hulk-like proportions. Other cities followed Portland, though more have wound up with systems like that in Tampa (about 1,000 boardings per day) than Portland (about 10,000).

The most recent boomlet in streetcar construction responds to changes in federal funding priorities, as the Obama Administration promoted livability through Transport Investment Generating Economic Recovery (TIGER) grants. (Previous federal funding sources were not amenable to streetcar service). Most of the lines are local circulators, connecting tourist and entertainment destinations. Many in fact are heritage lines, using historic streetcars (or replicas) to deliver passengers in the same fashion as 100 years ago, as in [Figure 11.2](#).

The problem of streetcars as transport is inherent in the technology, but also in how the technology is operated. To rely on transit, prospective passengers want frequent service – every ten minutes or better. Almost none of today’s streetcars achieves that frequency. It may look good on the watercolor rendering to have the streetcar in front of the building, but for actual users, a conveniently appearing streetcar is a rare occurrence.

In addition, though American streetcars seem to be cookie-cutter systems, in fact they all involve custom designs, driving up costs.

⁵ In 2017 Toronto installed a pilot project where streetcars on King St. were given traffic priority, parking was eliminated and traffic was restricted was put in place. Speeds increased and ridership improved by 11% during the following year.

⁶ 4.4 mph.

⁷ 7.7 mph.

⁸ (Condon 2012).

From a [cost-efficiency](#)⁹ perspective, streetcar systems should all use standardized parts and cars.

⁹§9.1.

Transport investments (both locations and choice of technology) are empowered by emotion and feelings, as well as magical thinking, at least as much as reason.

In the 1880s and 1890s the first generation of streetcars provided a huge increment of accessibility over competing modes (walking, horse). Today's political leaders seem to engage in magical thinking on the subject, claiming streetcars will have the same kinds of transformative effects today as a century and half ago. But unlike the 1890s, now streetcars provide no increment of accessibility over cars and buses. They allow no one to get anywhere faster than before. The entire argument rests on qualitative improvements.

As rational observers with formal training in transport, we have had a hard time understanding the emotional relationship even some people have with rail. Why do people like rail more than buses? Is it simply how they are operated, or that it is modern capital, or is there a psychological benefit some accrue by traveling on deterministic tracks instead of the highly stochastic, very complex, and widely diverging road network?

There are uncountably many theories on the matter, a large subset of those are discussed and critiqued in the following sections. While this chapter discusses transit, emotion rather than reason is also an important factor in the location of other transport modes.

11.1 *Ride quality*

'The Trolley Song' speaks to the smoothness of the ride.¹⁰

The quality of the ride on an LRT is smoother and less herky-jerky than a bus, and passengers have a nicer facility.

The ride quality issue is primarily one of new infrastructure than of rail or streetcar infrastructure, though to be clear, it is probably easier to keep rail infrastructure smoother than roads. In the waning days of streetcars, people praised the new buses for their ride quality.

For a young musically-inclined romantic, even a bus can be idealized. For the regular commuter or the harried shopper, *bump, bump, bump* is far from romance.

¹⁰ 'The Trolley Song' was penned by Hugh Martin and Ralph Blane and most famously sung by Judy Garland in the 1944 film *Meet Me in St. Louis* about the 1904 World's Fair:

"Clang, clang, clang" went the trolley

"Ding, ding, ding" went the bell

"Zing, zing, zing" went my heartstrings

For the moment I saw him I fell

"Chug, chug, chug" went the motor

"Bump, bump, bump" went the brake

"Thump, thump, thump" went my heartstrings

When he smiled, I could feel the car shake.

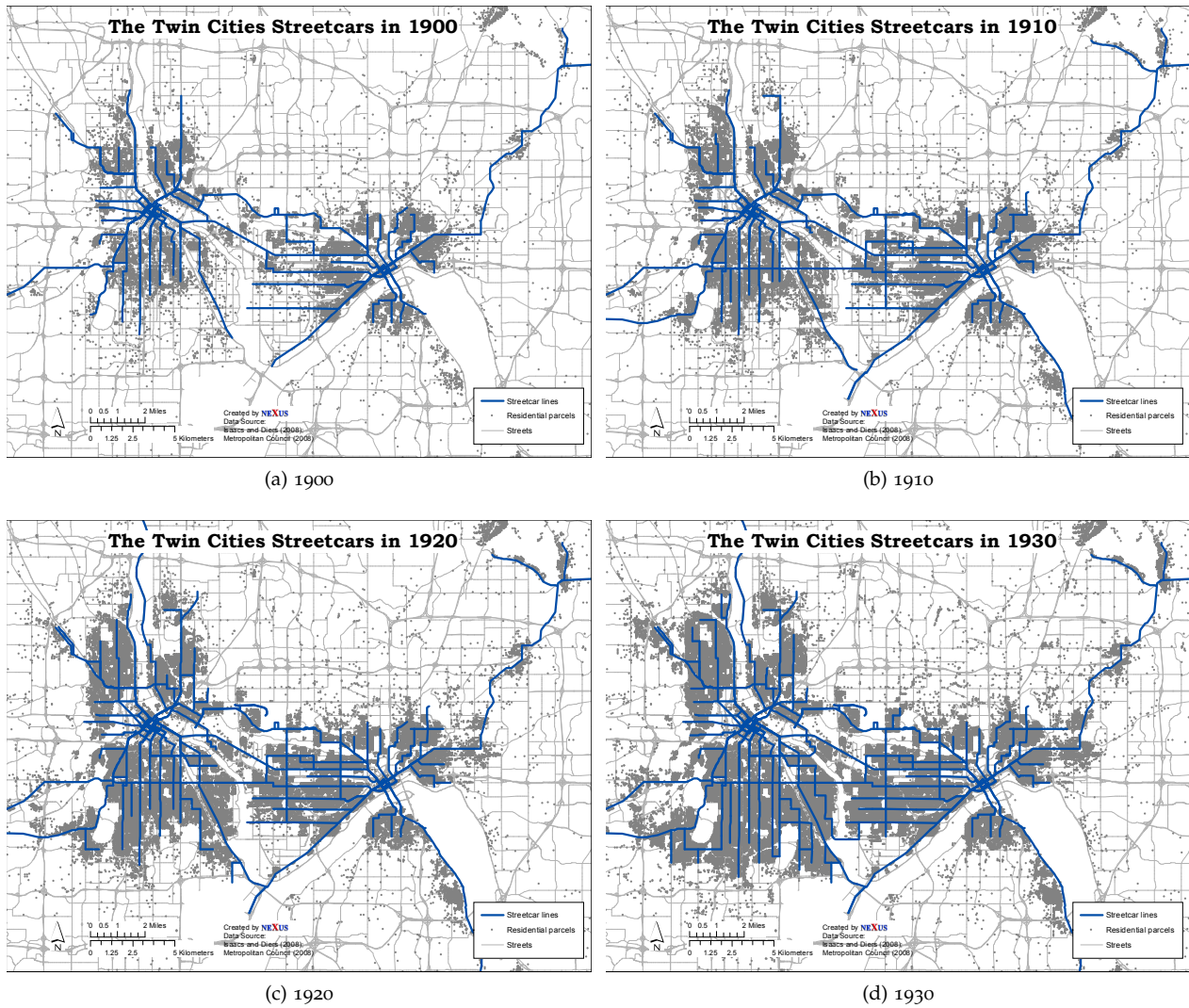


Figure 11.3: The joint development of streetcars and suburbs in the Twin Cities. Source: Xie and Levinson (2009)

11.2 *Speed*

Transport is about speed (and frequency and reliability). While speed has historically risen overall, speed (and reliability) on any particular transport facility tends to decline with age. The day it is deployed is the fastest the system will ever go, and over time it will slow. While there are occasional improvements, as infrastructure ages, it declines. Roads get more congested and more access points, reducing speed. Transit wears out, is shut down for maintenance, or slowed down in work zones, has stops added (more than they are eliminated). New is usually faster, but more importantly, limited access is faster. We can and do build new transport facilities that are overall slower (though more frequent) than existing transport, but that is harder to justify, so it is always pitched as faster, even if in contradiction to the facts.

Trains are faster than local buses if they have their own right-of-way and few stations. Bus rapid transit (BRT) on exclusive right-of-way is faster than buses in mixed traffic as well. Streetcars lack exclusive right-of-way. Exclusivity is the fact that distinguishes streetcars from LRT in most US definitions, although the terminology, and its use, are fuzzy. Streetcars are thus not inherently faster than buses, and may be slower since they stop at every stop, while buses can skip stops lacking passengers.

11.3 *Operating costs*

Some advocates argue from a systems perspective, which while of little import to the daily rider, matters to the bottom line. Trains, with a single driver pulling multiple carriages, and electricity rather than fuel, may have lower operating costs (cost per passenger km) than buses. Clean electricity powering a streetcar will save energy and reduce environmental impacts compared to a diesel, or even an electric, bus in traffic. We do not have clean electricity (yet) in most of the developed world, so while the energy claim may remain, the environmental one is weak at best. The labor argument may also hold if you have a long streetcar that carries more passengers per driver than a bus. Germany has double-decker buses that hold 128 passengers, while streetcars by Skoda hold 157, as with all things, it depends on configuration, but it is not a knock-out punch. And it is only critical on routes and times with that level of demand. And if to achieve that demand, you lower frequency, you are worsening service.

Table 11.1: Twin Cities Metro Transit Annual Costs (excluding initial construction, 2006).

	Bus	LRT
Capital	\$41,728,775	\$21,559,465
Operating	\$208,249,261	\$18,725,334
Total	\$249,978,036	\$40,284,799
Daily Pax	212,088	28,147
Total/pax	\$3.88	\$4.50

Offsetting the operating cost advantage is the major capital cost disadvantage. Buses can effectively free-ride on streets paid for out of property and gas taxes, while streetcars are responsible for their own tracks (and BRT on exclusive right-of-way similarly are responsible for their own pavement). Does the \$100 or \$200 million dollars spent per line garner any new passengers? Are the existing passengers qualitatively better off in a way that they would actually pay for? Is the trip any faster? If the service were indeed better, it should be able to charge a premium and retain its customers.

Further offsetting this is scale economies. Cities that have buses will continue to have buses. At first, and for a long time, those same cities will have few streetcars. The buses will have many people working on them, a collection of spare parts, expertise, and so on to keep them maintained efficiently. The greater the number of distinct technologies used, the lower the economies of scale that can be achieved with any one of them. Streetcars will, especially at first, be rare, without the library of spare parts, without the staff maintenance expertise, and without any of the other advantages of buses. Either costly redundant vehicles will need to be provided, or the system will be ‘out’ more frequently than buses. As the data in [Table 11.1](#) shows, it is not even necessary that LRT has lower annual costs than bus, even after neglecting the quite large initial construction cost.¹¹

¹¹ More recent data, including the 2014 Green Line, looks better for LRT in the Twin Cities. The point is that looking at some costs (such as operating only) to the neglect of annual capital costs, much less initial capital costs, significantly biases the perspective.



Figure 11.4: A lit T sign in Vancouver.

¹² (Haugen 2006).

11.4 Navigability

It is hard to navigate current US bus systems, while the fewer number of rail lines are fairly easy to figure out. Because trains cannot steer, they cannot get lost the way a bus can.

An article in a local Minneapolis newspaper, “A Streetcar Named Development”¹² discusses the potential for streetcars for Minneapolis. In the closing quote, Teresa Wernecke, director of the Downtown Minneapolis transport Management Organization says “With rail, you know where you’re going.” The implication is that with bus you don’t. The navigability problem with streetcars is solved by wires in the air and tracks on the ground, which tell you where the service is going. Buses on undifferentiated blacktop have no such obvious signals. In one sense this is correct, but this is easily solved with better signage, and more importantly, tall lights with ‘T’ on them as deployed on arterial rapid bus lines, which can be seen from several stops away, as illustrated in [Figure 11.4](#). Not to mention this can be solved through smart phone routing apps, such as Google Maps. This has been enabled by the remarkable

standardization on the General Transit Feed Specification (GTFS)¹³ and the use of automated vehicle location (AVL) to locate buses in real-time.

¹³ (McHugh 2013).

In contrast to the assumption that rail is deterministic in its destinations, we present an anecdote: In London¹⁴ on rail, you don't necessarily know where you are going either. Returning home from Imperial College on the District Line, one might board a Wimbledon-bound train at the South Kensington Station towards a destination at Putney Bridge.

¹⁴David Levinson lived there for a year (2006-07). This is based on his experience.

Well, more than once, before the train reached Gloucester Road station, the conductor announced the train has been redirected to Ealing Broadway, and all passengers bound for Wimbledon (or points in-between) needed to change trains at Earl's Court.

While this is not a big deal, walking from one train on the platform to another across the platform, it created a lot of confusion. Native Londoners were asking visitors and tourists what was going on.

Those in charge of dynamically rerouting the trains may have had a good reason for this (another Wimbledon-bound train was already at the Earl's Court platform, one for Ealing must have been held up somewhere upstream), trying to balance service or flow of trains.

If this had only happened once, one might say, "that's strange." But this happened about monthly. If you missed the announcement you would have to backtrack. This does not regularly happen with buses. (Though sometimes they are cut short due to works or events.)

The point is that:

- When you have a complicated system, this creates opportunities to dynamically reroute (on a single line system, the exercise would be meaningless), and
- There is not something inherently more secure or informative about rail over bus.

Real-time apps could, in principle, inform travelers of such unusual activities, but as of this writing, most travelers are not using them, and the rest are using them to choose a vehicle to board, not expecting the vehicle they boarded would change midstream.

11.5 *Payment and boarding times*

An advantage that rail stations often hold over bus stops is in how trips are paid for.

Transit companies are moving to requiring smartcard (and credit card and smartphone) use for buses as well as trains, though this movement is much too slow.

Smartcards are often standard for trains but not buses. On a bus, payment is usually onboard. Cash payment takes about 6 second per customer to process when boarding, while smartcard users are at 2 seconds per customer.¹⁵

¹⁵ Based on work from a student paper.

Boarding times are reduced further still with prepayment and all-door boarding. Right now this is standard on trains of all kind, and rare for buses, but there is no need for this to be so. Payment readers can be installed at bus stops, starting with the busiest.

Reducing boarding time benefits not only transit passengers by speeding the trip, but by making the bus go faster, enables more runs per bus per day, increasing operational efficiency and driver productivity and the frequency of service that can be attained from the fixed fleet.

Any location worthy of being served by fixed-route transit is worthy of an off-board fare-collection mechanism (to speed boarding) at every bus stop, as ubiquitous as modern parking meters, which can take cash, coins, pin-and-chip credit cards, and near field communications (NFC) embedded in modern smartphones.

11.6 *Nostalgia*

Famously, Minneapolis and St. Paul saw their streetcars 'bustituted,' a word meaning substituted for by bus, by 1954, and many mourned their loss. But Minneapolis and St. Paul were not alone. Streetcars were obsoleted worldwide. Yet we don't go to London to visit their famous double-decker streetcars (at least not since the 1920s). We don't see them in New York or many other world cities. Trams disappeared in Sydney in 1961, though Melbourne kept theirs. There are reasons for this.

People who like rail recall (or wish they could recall) the immediately post-World War II America when streetcars were at a maximum.¹⁶ The year 1946 was a magical period in US history, a boom following the long depression, when streetcar networks if not at a maximum were really close. Though streetcars were clearly on the decline everywhere, this loss is felt deeply in the Twin Cities region.

¹⁶ Perhaps coincidentally, this is also the ideal time for model railroad enthusiasts, as it authentically permits the mingling of steam, electric, and diesel model trains.

Losses (of things we want) are always felt more than gains. Having the streetcars did not make residents as happy as losing the streetcars made them unhappy. This observation connects with

Prospect Theory of Kahneman and Tversky,¹⁷ and helps explain why change is so difficult. We are loss averse. Even today, people who were not born in a place feel outrage by the change that occurred.

¹⁷ (Tversky and Kahneman 1981).

Loss aversion can be rational as a signaling mechanism. If you believe we will be 'irrationally' upset at losses when you take something from us, you will be less likely to take it. You will also over-compensate us if you do take it, so that we will feel that we have been properly compensated.

11.7 Novelty

The flip side of nostalgia is quest for novelty. People like new things better than old things. Anything new (and shiny) has some appeal, especially compared to old and run-down. We invent words to make old things sound nicer than they are (historic, classic, vintage, legacy, antiques, previously owned, well-loved, patina). While once streetcars were old and buses were new, the opposite is now (or soon will be) true.

11.8 Conspiracy

There is a thought widely held that a conspiracy of automakers and oil companies undid the streetcars. Conspiracy plus nostalgia is not without power as an explanatory force.¹⁸ The conspiracy as told is not quite what happened, and most objective observers agree the streetcar's mid 20th century demise was driven by economic factors.¹⁹

¹⁸ Possibly due to the popular film *Who Framed Roger Rabbit*.

¹⁹ (Slater 1997).

Yet in many conspiracies there are kernels of truth that are exploded into popcorns of myth. The aging tram system of Brisbane was burned in the mysterious Paddington Depot fire.²⁰ Phoenix lost most of its streetcars similarly.²¹ Unlike the situation in most of the United States, the loss of streetcars in the Twin Cities was in fact the result of a criminal conspiracy. *The Transportation Experience* notes:²²

²⁰ (Turnbull 2002).

²¹ (Fearnow 2016).

²² (Garrison and Levinson 2014).

The streetcar lines in the Twin Cities were built by Tom Lowry in the nineteenth and early twentieth centuries, and like many cities were aimed at large part in land development. For the period between 1925 and 1948, fares held steady at \$0.10, leading to capital shortfalls. The Twin Cities lines were publicly traded and most shareholders were non-local. The conversion from streetcars to buses took place after a series of events helped drain the company of even more resources. In 1949, Charles Green undertook a hostile takeover. He asked for a fare hike, fired 25% of the workforce, and canceled capital investment. He



Figure 11.5: Litter outside the Franklin Avenue LRT Station, Minneapolis. Photo by David Levinson.

was employing a traditional ‘cash cow’ model, wherein new owners milked the system of resources to pay for its own takeover.

A strange turn took place when Isadore Blumenfeld, a.k.a. Kid Cann (rumored to be a gangster and murderer) and Fred Osanna (known to be a lawyer) tried to take the system from Green. The State Railway Commission made an investigation of bribery, embezzlement, kickbacks, and death threats. Osanna and company did successfully takeover the Twin Cities Rapid Transit in 1951, and sold off the streetcars and many of the rails. It is reported that the vehicles are still running in New Jersey and in Mexico City, though while the shells may still operate, whether the mechanics in the vehicles do is unclear. Osanna claimed “the fastest and most massive streetcar-to-bus conversion ever undertaken in any major US city.” However, Osanna wound up in jail for fraud. The system was subsequently sold to Carl Pohlad (later owner of the Minnesota Twins), and was eventually sold to the public Metropolitan Transit Commission in 1970 for \$7.9 million.

11.9 *Amenity*

People like amenities, features, gadgets. Some of them are genuinely useful, like the LRT station variable message signs which are supposed to tell you how many minutes until the next train. Shelters and heat are nice in bad weather. Pre-paying saves time. Working, real-time signs can provide useful information which relieve anxiety. New systems are coupled with amenities that old systems lack.

11.10 *Sexuality*

Jonathan Richmond identified sexuality as an explanatory force in his book *Transport of Delight* and earlier paper “The Mythical Conception of Rail Transit in Los Angeles.”²³ The image of the train entering the tunnel clearly evokes a primal response. A bus entering a tunnel would not have the same length, and thus presumably fall-short in the primal response department.²⁴

11.11 *Respect*

Some people won’t ride buses. Buses are perceived as a means of travel for the lower classes. These same people would be happy to ride an intercity coach, or a London Routemaster double-decker bus, or a tourbus, or have their kids ride a school bus. It is not the technology, it is a matter of respect and status. If buses are perceived

²³ See (Richmond 2005).

²⁴ Whether mass transit needs to be sexy has been disputed. (Jaffe 2013b).

as being for the lower classes, people striving to be in (or stay in) the upper classes will avoid them.

But this is not about buses, it is a more general issue.

The Hiawatha (Blue Line) LRT opened in Minneapolis in 2004. Soon thereafter it was already beginning to feel rundown. The litter-strewn (Figure 11.5), ticket-machine-jammed Franklin Avenue LRT station “just makes you feel poor.”²⁵ Located in a no-man’s land beside Cedar and Hiawatha, it is not a place one feels safe walking to, especially at night. At the end of a Minnesota winter the accumulated detritus of six months past is just par for the course, but apparently no one claims responsibility for cleaning up the hill adjacent to the station, or the boulevard²⁶ along the street. This is the same kind of big investment in capital but “not one penny for maintenance” philosophy that led the buses to decline, and the streetcars before them. At least there was a police car parked next to the station, hopefully deterring violence that is dragging some systems down.

The perception of transit as a failure is succinctly summarized in the wrongly but widely misattributed²⁷ quote: “Any man who finds himself on a bus over the age of 26 can consider himself a failure in life.”

²⁵ Spoken by David Levinson’s wife.

²⁶ The term ‘boulevard’ in the English language of the Upper Midwest refers to the green planting between sidewalk and street. In other places this is sometimes called a ‘nature strip’ or ‘verge.’

²⁷ It is said Margaret Thatcher said this, but there is no evidence. Instead Loelia Ponsonby is probably the source. She was the model for Miss Moneypenny in the James Bond universe.

11.12 *Status*

People like to live with people who are like them, or their economic ‘betters,’ who raise their status by association. This process explains economic sorting in real-estate markets. It should be no surprise that people want to ride with people who are like them, or their economic ‘betters,’ who also raise their status by association, and don’t want to ride with others.

This ‘people like us’ phenomenon also leaks into the taxi vs. Uber/Lyft debate. Uber and Lyft drivers are more like ‘us’ (if ‘us’ is middle class folks and above) than your typical taxi driver.

The decision of the ‘choice rider’ (as opposed to what was once unfortunately called ‘captive riders’ in the field, and then ‘transit dependent,’ and now the more positively-framed ‘transit reliant’) to ride the bus depends on whether other similar people ride the bus. Presumably they are making the same kind of decision. They are not considering the [positive externality](#)²⁸ (virtuous cycle) that their riding the bus increases the likelihood someone like them rides the bus (and their not riding the bus lowers the same likelihood in a vicious cycle). Like any positive feedback system, this is both a cause and an effect.

²⁸ §7.

The potential choice rider who doesn't ride transit, or more specifically the bus, chooses not to ride because of reasons of efficiency (compared with the car), and respect and status (compared with the car and the train). Their not riding makes the status question even worse.

Imagine there are two transit services in an area, a low quality system (L) that is pervasive (everyone is within 400 m ²⁹ of a low quality stop) and a high quality system (H) that is skeletal, only a small fraction are within the same distance of a high quality stop.

²⁹ $1/4$ $mi.$

Imagine there are two classes of potential users, poor people (P) who will use either system, and rich people (R) who will use only the high quality H routes.

Poor people perceive the system as larger (both L and H) and get more network externalities from the system. They can go anywhere in town on transit. Rich people see a small system, and perceive few network externalities. They can only go places on the H system.

As a consequence, poor people are more likely to use the system than rich people. The lack of choice riders weakens the political constituency for improvements.

Try to tell people at dinner party they should willingly ride on an old, slow, amenity-free service with people who they otherwise would not associate with, even though they don't have to and can afford alternatives, and they will smile and turn to the next person. They don't want to feel second-class, so they don't ride, but they also don't want to feel guilty about not wanting to feel second-class. All too-often, this mode is 'bus,' especially in cities without historic, classic, and patina-ed rail systems.

Instead tell people who have a choice that they can ride on a mode that is new, fast, with amenities, and with people who are like themselves, and they might consider it from time to time, and more regularly if it is cost and time-effective. This mode need not be rail.

Unlike a new, fancy, and expensive rail system, existing buses are now the opposite: old, basic, and cheap. There are several solutions to this problem. The expensive solution is to build high quality services everywhere to attract the fraction of R that would not otherwise take transit. The less expensive solution is to change the perception (and reality) of the low quality system so it appears higher quality. Give it as many of the same features of H as possible, starting with information (such as what bus stops at the bus stop, when does it stop, what hours does it operate, where does it go, what does the local neighborhood look like, is the bus on-time, how much does it cost) and navigability.

Instead agencies sometimes exacerbate the problem. In a recent branding effort, The Twin Cities' Metro Transit tried to differentiate their services.

'The METRO system name identifies the developing LRT/BRT services as unique,' said Arlene McCarthy, director of Metropolitan Transport Services for the Council. 'METRO riders can expect fast, frequent, and convenient service, whether they ride the Blue Line to Target Field, the Red Line to Mall of America, or the Green Line to the State Capitol.'³⁰

³⁰ (Metropolitan Council 2012).

By implication the some 80% of regional transit riders who use local buses can expect slow, infrequent, and inconvenient service, whether they ride the 3 to downtown or the 67 to Franklin Avenue Station. This framing aims to diminish local buses into second-class service.

There is nothing technically preventing the bus and bus stop from being nice, (basically as nice as a brand new train and rail station, but usually a lot less expensive) but the reluctance on the part of the public from doing so. The best example of trying to reverse this status problem is the new rapid bus A Line serving St. Paul and Minneapolis.³¹ Whether this will spread is unclear, though a large set of these rapid bus lines are under consideration 11.6.

³¹ (Palmateer et al. 2016a).

Bus transit has more than an image problem. Its image problem results from the reality of services, which are due to the rail-favoritism, which results from bus's image problem. It is a vicious cycle.

11.13 Pedestrian accelerator

Streetcars running along shopping streets can function as a 'pedestrian accelerator,' supporting walking trips who might hop on and off a slow moving streetcar with frequent stops. Why a streetcar is any different from a slow moving bus in traffic on the same corridor, especially one that is marked as a shopping circulator, is never made clear. It is also not clear why pedestrians need to be sped up. If pedestrian speed is of interest then a moving sidewalk may be a better answer.

11.14 Traffic calming

By moving in traffic rather than an exclusive right-of-way, streetcars are slower than LRT (or BRT). Some, especially those with the 'slow travel' movement, claim this as a virtue. Others argue that moving in traffic slows traffic, and thus it acts as a traffic calming mechanism, and improves the quality of pedestrian activity in the

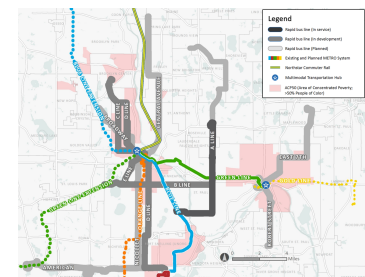


Figure 11.6: Rapid bus network.
Source Metro Transit.

corridor. Again, why a streetcar is any different from a slow moving bus in traffic on the same corridor is never made clear.

11.15 *Superstructure*

Rail transit forms an urban superstructure. Guideway transit, especially LRT makes the city more like a single structure, and makes everything seem closer. The LRT vehicle is continuously running, and if activities are along the path of the vehicle, everything seems quite coordinated. In a way, by organizing activities linearly (or multi-linearly), it simplifies the city. Hopping on a train is much like getting on an elevator.

LRT, like walking indoors, keeps you enveloped within civilization, while walking, biking, or driving is a frontier experience, you alone in the wilderness. Bus falls in-between. We can posit that distances within buildings seem shorter than equivalent distances between buildings. Distances connected by the urban superstructure will likely feel closer than those which are not so connected. Walking through a modern airport, or the Minneapolis Skyway, or the Mall of America, will tell you enveloped distances can be quite large, but still not feel as large as leaving one building into nature for another.³²

Preferences for civilization or frontier-crossing (or degree of each) vary across individuals. Driving of course places you in a machine, but you, not civilization, are operating the machine, so just as driving is freedom, not everyone wants that freedom to drive, they may prefer freedom from driving. The extent to which you believe in the importance of community over individuals (or vice versa) will affect your perception of the issue.

11.16 *Feedback*

Transit invokes further passions because of the positive feedback loop between ridership, revenue, and route frequency, especially where transit is weak as in much of the US. Our riding transit creates a **positive externality**³³ for you: more riders, more frequent vehicles, and more routes, leading to more riders. So of course transit riders want to impose their preference on non-riders. It is only selfishly rational. Rail transit attracts more riders per mile than buses.

Further, cars use scarce roadscape, create congestion, and make bus travel even slower. While similar feedback loops may exist on the highway side (more drivers means more closely spaced roads),

³² The etymology of *trans-port* comes from the Latin for across or through the gate or door. We might think of travel within an enclosure as *cis-port*.

³³ §A.4.

congestion mitigates that and the network is largely built out, so drivers do not feel the same need to impose their modal preference on the transit-riding minority.

Finally, drivers may benefit in the short term if other drivers take transit. Where transit is already congested and frequent, additional riders produce few positive externalities as diminishing returns set in.

11.17 *Congestion reduction*

Matt Kramer, then a Minnesota Chamber of Commerce representative lobbying for additional public transit and transport spending (then, as always, being debated at the Minnesota Legislature) is quoted as saying

“Every person who is riding transit is one less person in the car in front of us.”³⁴

³⁴ (Owings 2015).

This is a fascinating quote. First is the use of “us.” So the Chamber of Commerce (probably correctly) identifies riding transit as something someone else does (since “we” are still in the car). And goes on to imply that it benefits “us” because there will be fewer cars.

This evokes the famous Onion article: “Report: 98 Percent Of US Commuters Favor Public Transport For Others.”³⁵

³⁵ (The Onion 2000).

But it also suggests transit reduces auto travel. The converse is almost equally true, building roads reduces transit crowding. But that is not an argument road-builders make. It is an argument urbanists make against roads.

Of course, some transit users would have otherwise driven, but many would have been passengers in cars, walked, ridden bikes, or telecommuted. No one really knows what the alternative untaken mode would be.

While there are surveys that have answered those questions, they are all context specific. For most riders, transit lines are not a direct substitute for driving.

Most transit users would not otherwise drive themselves. For instance, the 2004 Minneapolis - St. Paul Metro Transit bus strike could not be detected in the traffic counts. Most displaced users carpooled, walked, or biked. That is not to say there was no hardship; there was, but it was felt by transit users not drivers. And sometimes in a larger city, the fear of a strike or an actual shutdown will cause people to work from home for a short period, reducing traffic for at least a few days.

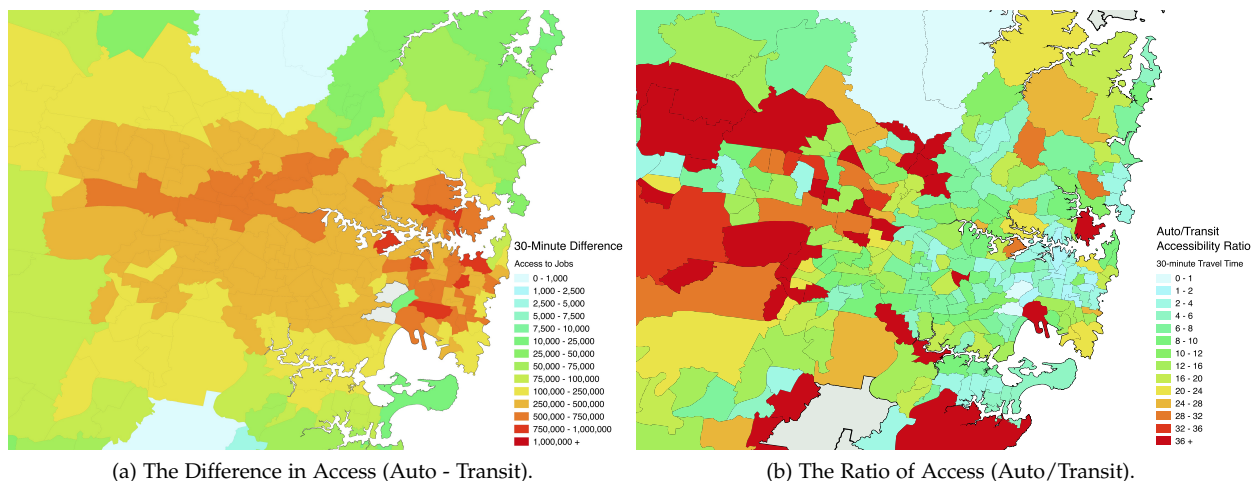


Figure 11.7: Automobile vs. Transit Access in Sydney.

The line of reasoning in the quote above suggests the primary purpose of transit is reducing auto travel, rather than serving people who want to, or have to, use transit. This by no means an original claim. In other words, building transit is good because it reduces traffic congestion.

That is at best a secondary benefit, a benefit which could be achieved much more simply and less expensively through the use of [prices](#)³⁶ as we do with almost all other scarce goods in society, even necessities like water.

³⁶ §6.

Transit today is, in most markets, slower than driving, and as a result the access by transit is lower. As shown in Figure 11.7, people who depend on transit can reach fewer jobs than those who have automobiles available. Some people use transit by choice, for instance to save money (if they need to pay for parking), and the rest without choice.

From an equity perspective, it is more important to spend scarce public dollars to improve options for those without choices than to improve the choices for those who already have alternatives. Perhaps ideally we could do both; in practice, one comes at the expense of other.

The purpose of transit is moving people from *A* to *B* who want (and/or don't have a good alternative) to use transit because it is faster or less expensive or more convenient than the alternatives. Their willingness to pay for that trip is the primary (and perhaps dominant) benefit transit provides.

The idea that transit is for the other person is true for the 95.5% of people who don't use transit regularly. But it warps thinking that the aim of public transit funding is to benefit those non-transit users.

11.18 *Transportainment*

Transport and entertainment are ever inter-twined.

Every movie is a road trip, and not just the obvious ones, like *Thelma and Louise*, or *National Lampoon's Vacation*, or *Apollo 13*. The linear narrative of movies is constrained to follow the single dimension of time, marching ever forward. While attempts at braking the strict linearity are possible (think about flashbacks, or *Rashomon*-like stories, or *Pulp Fiction*) within those cul-de-sacs it remains a road trip.

Many stories star or feature transport. Not just the obvious ones like, *Speed*, the *Faster and Furiouser* series, or *Gravity*, but any story which involves motion and gadgets. In some cases they attain human-level personality, like *Herbie, the Love Bug* or all the anthropomorphized vehicles of *Thomas the Tank Engine* and its ilk.

Outside of movies, sporting events too are about motion. Running of course is simply who can move the fastest (unaided, unhindered). Hurdles is who can move the fastest, with hindrances. American Football is about who can move a ball across about 90 meters of territory with a limited number of stops for committee meetings, hindered by violent resistance, ensuring at least steady progress.

NASCAR, a sport that emerged from the use of cars during the period of prohibition of alcohol to outrun the law, is even more obvious. Going around a racetrack in a vehicle 400 times is interesting enough to attract more than 145,000 people to attend an event at the Charlotte Motor Speedway and seven million people to watch on TV. Though, apparently, in-person attendance is dropping. While we might complain about dozens of vehicles traversing 966 km³⁷ and doing no physical work (i.e. returning where they started), the more severe environmental consequences of the race are not due to the racers, but the fans, traveling hundreds of miles themselves.

³⁷ 600 mi.

Having now been to Charlotte, the Charlotte Motor Speedway, and the NASCAR Hall of Fame, we have first hand knowledge of the magnitude of racing in the local culture. You too can drive a car on a race track for a not inconsiderable piece of coin. You learn that people have purchased condominiums overlooking the race-track. You learn they are now 'right-sizing.' You learn the stands are multi-colored so they look more full in ads even when they are not.

Not only is entertainment about transport. Transport has become about entertainment.

We are not talking just about the in-vehicle entertainment systems designed to entertain you while you travel, thereby making travel less onerous (and more frequent).

Many, if not most, of today's transport network investment decisions are made by people who won't regularly use the thing they are deciding on. In one sense, this must be true, there are many facilities, and only so much time in the day for decision-makers to travel, given our relative centralization of decision-making in the hands of government.

It is not only the specific links and segments of networks, but entire modes that go mis-understood. As we noted above, many people argue, if not believe, that the purpose of transit is the reduction of congestion, one less car in front us.

Decision makers may try to imagine how they will use the facility, but cannot develop a full scenario moving their home and workplace and other activities to advantage themselves of the corridor, which would enable them to see the package as a regular user. They are limited to envisioning their occasional interaction with the link or mode. They think WiFi matters more than frequency or direct service. In this sense, they are viewing the facility the way a tourist might, rather than an everyday user.

The decision-maker's (or anyone's) view of the transport modes, links, and vehicles that they don't use is like your view at the amusement park or a place where you are a tourist: a ride, part of an urban entertainment package, an appendage to a game or concert or night-on-the-town wrapped up as an event.

These rides-cum-transport are designed to lure people who have nothing better to do with their time than be entertained. If these projects were self-financing, more power to them – perhaps raising emotions of disdain for those who have nothing better to do with their time but spend it on a ride and trivial amusements, but not particularly impacting anyone else.

Unfortunately, these investments are not self-financing, except in the fantasies of economic development analysts and perhaps in the special case of Pedal-Pubs.

It heeds the cry of the child: "I'm bored, entertain me."

It is fantastic that decision-makers believe our society has so much wealth and so many resources that there are no more important problems to solve, that we can build urban amusement park rides for the sake of the novelty-seeking joy-riders. That we can prioritize circuses over bread. That we can rise up Maslow's

*Hierarchy of Needs*³⁸ from security and basic mobility to societal self-actualization and social entertainment. That we can fuse entertainment and transport into a newly converged *transportainment* (hopefully obviating the need for entertainment on the subject).

Do they really believe that?

Certainly, most travel is not 'work' travel (most people don't have regular jobs), but much of it is productive (or re-productive). And if everyone had the opportunity to simultaneously have adequate housing and adequate transport, then public subsidy for transport as entertainment (or housing as entertainment – which in the US is generally left to the private sector) would not be the worst way to spend our social surplus.

Yet we keep hearing that there is insufficient affordable housing, and more than a few people walk or ride bikes not out of choice but for lack of affordable faster modes, and many people *ride on buses*³⁹ that take 2 to 3 to 4 to 5 times as long as cars for the same trip (not even considering schedule delays) because they cannot afford or otherwise cannot drive a car, and because the transit system is so poorly designed it takes so long to get to many places.

Every \$2 billion spent on rail as part of the urban transport-entertainment complex is \$2 billion that cannot be spent on more serious and economically productive urban needs of travelers without the luxury of time and choice, improving their safety and reducing their travel times, or just giving them the resources to make choices.

11.19 *Permanence and directness*

It is claimed that rail induces economic development. A developer can make a permanent investment decision based on the location of rail lines, as the transit system is committed to this line, while a bus line may be temporary, and thus not induce as much development. Even if we don't believe that 'bus is temporary but rail is permanent' argument ourselves, if we believe other people believe it, it creates the consensual hallucination that organizes development and turns in to a self-fulfilling prophecy. The rail line thus acts as a coordinating agent.

The simple fact that after some point in time most cities that had streetcars lost them (for instance 1948 in Phoenix, 1954 in the Twin Cities, 1961 in Sydney) belies their permanence. Yet on almost every former streetcar route, today we see continued bus transit service. This indicates the service is permanent if the demand is there, not

³⁸ §2.

³⁹ §21.

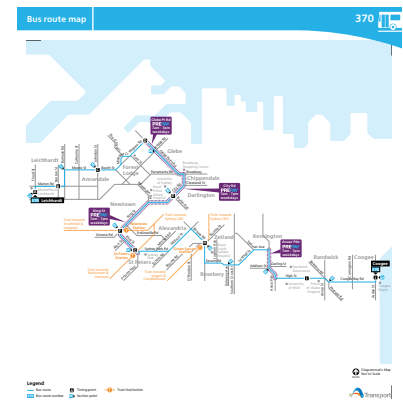


Figure 11.8: Sydney's 370 Bus is highly circuitous.



Figure 11.9: Historic Sydney Tram Map. Source: Wikipedia.

the physical instance or particular technology. We can further look at the built form of cities which have made significant commitment to bus rapid transit (Ottawa, Curitiba) to see evidence of development following the service, not the technology. BRT of course is more comparable with LRT if it runs in its own right-of-way. Arterial BRT or Rapid Bus, sharing the right-of-way with cars, is more like streetcars or trams.

Even more notably, bus routes can be quite long-lived. London Buses route 22 was introduced on May 17, 1909. By 1911 it had evolved into the route that served as the link between Putney Commons and Piccadilly Circus. (The route was extended from Putney Bridge to Putney Commons in 1916). The route has evolved some since that time mainly being split into two pieces, the northern branch ‘shortworkings’ designated 22A, 22B, and 22C and later 242. The 22 was later stopped at Piccadilly and the Northern shortworkings were fully separate routes.

Why is this of interest? A continuously numbered bus has managed to last over 100 years on largely the same route, longer than most rail services. One could attribute this to bureaucratic inertia, but it also helps locals at least retain knowledge about their transport geography.

There is however an aspect of embeddedness that works to the advantage of streetcars over buses. This is the resistance to rerouting. Tracks are more expensive, so once laid down, tracks are harder to move than buses. This means it is harder to make routes circuitous. Many bus routes look like they were designed by drunk transit planners. One particularly egregious local bus in Sydney, the 370, (Figure 11.8) which runs near David Levinson’s office and home, is so circuitous it is faster to walk even ignoring schedule delay (which happens to be the highest in Sydney).⁴⁰ This is hardly a problem unique to Sydney, we have studied transit circuitry in the US and found it far worse than typical travel by road.⁴¹

There are undoubtedly reasons for every indirect zig that diverts buses from the strait and narrow, its aim is to collect passengers. Serve this building, serve that one, cover this street, reduce pedestrian walking time. However, every circuitous zag also loses passengers by increasing running time for everyone on-board.

In contrast, trams in practice are much more straitlaced, paragons of transit routing virtue. The historic Sydney Tram Map (Figure 11.9) gives a sense of routes that were pretty much as direct as possible.

It can be argued the 370 bus provides an east-west service that no tram did, which is true in part. But that doesn’t mean trams could not. It also could be argued that almost no one rides the 370 end-to-

⁴⁰ (Gladstone and Morgan 2018).

⁴¹ (Huang and Levinson 2015).

end. Though we have not checked the Opal smartcard data, this is probably true as well. But a well-structured suburb-to-suburb transit network could avoid this.

11.20 *Development-oriented transit*

“Item! Subsidies requested for project built along transit line that itself was built with subsidies justified by promise of economic development. *chomps cigar*” – Nick Magrino.⁴²

⁴² Nick Magrino quoted from Streets.mn Forum, April 1, 2014 (Magrino 2014a).

WE SUBSIDIZE TRANSIT TO SPUR DEVELOPMENT

- Apple Valley hopes BRT line can spur development near transit stations.⁴³
- Twin Cities regional transitways will spur economic development.⁴⁴
- New Lechmere Station for MBTA Spurs Development.⁴⁵

⁴³ (Wolf 2012).

⁴⁴ (Metropolitan Council of the Twin Cities 2011).

⁴⁵ (Jessen 2011).

WE SUBSIDIZE DEVELOPMENT TO SPUR TRANSIT RIDERSHIP

- Feds grant \$2.9 million to ‘Reinvent Phoenix,’ light rail developments.⁴⁶
- Grants help fund Twin Cities’ transit-oriented development.⁴⁷
- Urban Transit Hub Tax Credit Spurs Development Interest in Newark.⁴⁸

⁴⁶ (Jimenez 2011).

⁴⁷ (Dornfeld 2012).

⁴⁸ (Corbalis 2011).

We as society cannot make up our collective mind whether we want development to drive transit use, or we want transit use to increase development. Advocates would say we want both to create transit-served high density communities because of all the good that it brings.

But if the transport-land use cross-dependency is so strong, why do we need to subsidize either, much less both, side(s) of the equation? If you subsidized transit to get the positive externalities which are beneficial to development, it might make sense. For instance maybe transit is under-supplied because the private sector cannot capture the positive externalities due to transaction costs and prohibitions on [value capture](#),⁴⁹ or because the automobile is subsidized. If even after subsidizing transit, and there is still not enough demand for private development to proceed without subsidy, maybe you are trying to stimulate development in the wrong place.

⁴⁹ §16.

Someone is profiting off of this, and it isn’t the public.

⁵⁰ (King and Fischer 2016).

New streetcar projects in the United States are almost entirely rationalized by increased real estate prices. An examination of projected benefits of recent systems shows that about 80% of all benefits – in particular, increased property tax revenue – are simply due to higher property prices.⁵⁰

From a developer's perspective, spending 'other people's money' on this urban amenity is a brilliant idea.

An even better strategy for developers is to get a subsidy (often in the name of affordable housing) for the transit-oriented development (TOD) adjacent to these newly constructed lines. Programs in a number of cities, such as those of the Livable Communities Act administered by the Metropolitan Council in the Minneapolis - St. Paul region, subsidize development along transit lines.

The best strategy for developers, of course, is both – a publicly provided system and public subsidies for TOD adjacent to it.

Although only implemented sporadically, land value-capture techniques, such as special assessment districts or tax increment financing, present strong opportunities for cities to recover some, all, or more than enough revenue to pay the cost of many types of transit infrastructure and operations. If streetcars are important to developers, and not particularly important to the traveling public, property owners should follow the example of the Grove shopping center, a retail and entertainment complex by Caruso Affiliated in Los Angeles straddling an iconic trolley: they should fund the streetcars entirely themselves. Caruso, though, is not immune to the siren song of free money. Now that they've seen the public largess going to other streetcar projects, they want their system extended,⁵¹ mostly paid by the public.⁵²

⁵¹ 3.2 km (2 mi).

⁵² (Bachrach 2013).



Figure 11.10: Bloomington Central Plan.

⁵³ (Moore 2018).

The claim of permanence inducing development is wrong. Sometimes rail lines induce development; sometimes they don't. Sometimes (most of the time) development occurs without rail lines. For instance, witness the LRT of Broken Dreams that is Bloomington, Minnesota between the Minneapolis – St. Paul International Airport and the Mall of America, which is the line's busiest station.⁵³ A station every 200 meters, and no business, just grass and asphalt and one park-and-ride ramp. The line has had nearly 14 years to attract development (more if you count construction, when it was obvious a line would be built) and no one has said "this is the place for me." The activities along the line past the airport seem to all pre-date it. There is of course a nice plan, shown in the Figure 11.10, with many tree circles, and a surprising amount of parking. Given all the hoopla and awards the plan had

won, we had once thought the developments (or at least some of them) there had actually been built. For now they are just imaginings.

In a recent debate, Minnesota's Metropolitan Council of the Twin Cities argued that it shouldn't have to fund local streetcars proposed for downtown Minneapolis, because they were more for economic development than for transport, and so Minneapolis should be seeking a different pot of money.

DO STREETCARS ACTUALLY DEVELOP THE ECONOMY? We have evidence in many historical cases of the co-evolution of transport and land use (such as London, New York, or the Twin Cities).⁵⁴ In those cases the transport mode developed was faster than alternatives, and therefore increased accessibility, making land more valuable.

Historical cases, while informative, are not predictive without considering context. We have no evidence that streetcars, of themselves, promote economic development in the context of present-day US cities. That is, there is no case where modern streetcars were built, nothing else was done by the public sector (no road reconstruction, no public subsidies for development, no change in development regulations), and the level of private sector economic development changed measurably, and more than in an otherwise comparable control case.

We have hypotheses as to why there should be no effect, and that is the maturity of the system (streetcars are not connecting places that are presently unconnected) and the lack of positive changes to accessibility (or even negative changes to accessibility) that comes with adding a slow mode to a network, which is already faster than it was in the 19th century.

ABSENCE OF EVIDENCE IS, IN FACT, EVIDENCE OF ABSENCE.

But in probability theory, absence of evidence is always evidence of absence. If E is a binary event and $P(H|E) > P(H)$, "seeing E increases the probability of H "; then $P(H|\neg E)$ [Probability of H given Not E] is less than $P(H)$, "failure to observe E decreases the probability of H ." $P(H)$ is a weighted mix of $P(H|E)$ and $P(H|\neg E)$, and necessarily lies between the two.⁵⁵

It is often said that "Absence of Evidence is not Evidence of Absence," but this is wrong. This is especially wrong in a context where we have motivated people searching for evidence.

Consider the example of Bigfoot. Bigfoot is a supposedly big humanoid or primate living in very small numbers (and

Table 11.2: Employment in Minneapolis and St. Paul from 1970 – 2010.

Year	St. Paul	Minneapolis
1970	170,490	265,090
1980	176,900	268,600
1990	172,578	278,438
2000	188,124	308,127
2010	175,933	281,732

⁵⁴ (Levinson 2007; Xie and Levinson 2009; King 2011).

⁵⁵ The very logical *Less Wrong* blog discusses this issue: Absence of Evidence Is Evidence of Absence: (Yudkowski 2007).

presumably hiding from humans). There was a fad in our youths for blurry pictures of Bigfoot to appear in weekly tabloids like the *National Enquirer* sold at supermarket checkout stands. However, as the comic strip *XKCD* points out, cameras are everywhere now, on billions of phones, and yet we have no more evidence of Bigfoot than before.⁵⁶

⁵⁶ (Munroe 2013).

Does this constitute ‘proof’ of the non-existence of Bigfoot? No, because one can never prove a negative.⁵⁷ It does however cause the rational among us to become increasingly skeptical about our hirsute friend’s likelihood of being real.

⁵⁷ See Popper (1953) on Falsifiability.

BUT FOR. We need to think in a ‘but for’ way when evaluating economic development claims.

Would the development not occur ‘but for’ this particular investment? Would it occur with streetcars and BRT, with only streetcars, with only BRT, with neither?

We can’t fully know this without running four experiments in four parallel universes. We can estimate this statistically by looking carefully at multiple cases that have already opened, under multiple conditions, and get likelihoods that effects are as estimated by the model. There are some examples of modern transit lines increasing property values, there are some examples of no effect, and there are even some examples of transit lines destroying wealth.⁵⁸

⁵⁸ Sometimes all found in the same study (Landis et al. 1995).

Once many studies are done, we can do a meta-analysis, and try to put the complexity of findings into some order. The meta-analysis is much more robust, combining the sample size of all of the studies it takes in.⁵⁹ These studies unfortunately do not generally apply to modern streetcars, which have very different characteristics than high capacity services.

⁵⁹ For instance, see (Debrezion et al. 2007).

There have been a few attempts to summarize the results of the streetcar and economic development debate. The Transportation Research Board’s Transit Cooperative Research Program basically finds an absence of evidence.⁶⁰

⁶⁰ *Relationships Between Streetcars and the Built Environment* (Golem and Smith-Heimer 2010).

None of the reports about economic development effects have survived a rigorous peer review process. So in the end, we equivocate. If the new transport infrastructure notably increases the relative accessibility of a place (compared to other places), it might attract some development that would otherwise go elsewhere. If it signals to developers to coordinate actions, and develop here, rather than there, it might also concentrate development. If we concentrate development, and create more accessibility, we might have some economies of agglomeration further driving growth. If, If, If.

	Enhanced bus	Streetcar	Starter Streetcar	Rapid bus
Line length (<i>mi</i>)	9.2	9.2	3.4	21.8
2030 Avg wkdy project boardings	13,400	19,900	7,200	34,700
2030 Avg wkdy new riders	-1,700	900	1,200	6,700
Capital cost (million \$)	94	393	200	110.7
Operating cost (million \$)	13.6	20.1	10.6	9.06
Capital cost / wkdy rider (\$)	7,015	19,749	27,778	3,190
Cost / rider / mile (\$)	762.49	2,146.6	8,169.93	146.34

Table 11.3: Costs and ridership of alternatives: Nicollet Alternatives Analysis and Met Transit's Arterial BRT study.

The evidence we do have is that employment in the core cities of Minneapolis and St. Paul is very stable, as shown in Table 11.2, independent of most of the vagaries of the economy, shifts from low rise to skyscrapers, construction of freeways and skyways, the expansion of the University, the rise of the dual worker household, and so on.

An anonymous source nicely summarized some publicly available information of the costs and ridership of alternative transit technologies in Minneapolis, shown in Table 11.3.⁶¹

Upzoning and development would be factored into all alternatives, especially since a number are already being developed without a streetcar or other improvement. These ridership projections also include the *Alternative Analysis's* assumption that streetcar riders perceive a 25-minute travel time savings (implicitly making their travel time negative in some cases), and thus more choose streetcar.

Do we really believe a small investment in infrastructure serving a thousand additional people per day will change urban development patterns? That would be the equivalent of urban homeopathy.

Advocates will advocate, that is their nature. If no one believes their small estimates of economic impact, the estimates will just grow and grow, so they can get attention. But don't confuse their advocacy with scientific knowledge, about which we have very little.

Are streetcars the best amenity? Are they the best transport service possible? Or do they drain resources that would otherwise be spent on something else, like maintaining and improving existing transit systems or serving many more passengers with Arterial BRT?

Unlike the case for LRT and even BRT, the peer-reviewed literature provides little evidence that streetcars actually increase land value – and the absence of evidence, when a systematic search is involved, is evidence of absence. One study did find that the restoration of

⁶¹ (Metropolitan Council of the Twin Cities 2012; City of Minneapolis 2013).

⁶² (Guthrie and Fan 2013).

legacy streetcar service in New Orleans after Hurricane Katrina was associated with building permits.⁶²

IS THERE SUCH A THING AS BRT-ORIENTED DEVELOPMENT? Above we asked if streetcars had economic development effects, and concluded we have no evidence to date. In contrast, for BRT systems, there is much peer-reviewed evidence, though not as much as we might like.

First, obviously the nature of the impacts depends on what kind of BRT you are talking about. Broadly, we can divide systems into freeway-based BRT systems with stations, and arterial-based BRT systems with stops. The differences are that stations are more elaborate than stops, and less frequent. Worldwide, systems are hybrids.

A 2008 review found wide variations in the types of BRT across many dimensions (speed, construction costs, ridership, subsidies, etc.) with some systems offering a peak headway of well better than 1 bus per minute, while others were at 10 minutes between buses.⁶³

⁶³ (Hensher and Golob 2008).

BRT thus has many distinguishing characteristics, ITDP developed a ranking system: the BRT standard.⁶⁴

⁶⁴ The categories for which points are awarded in BRT Basics are:

- Busway alignment: 7 points
- Dedicated right-of-way: 7 points
- Off-board fare collection: 7 points
- Intersection treatments: 6 points
- Platform-level boarding: 6 points

(Hook et al. 2012).

⁶⁵ This is appropriate given the color of the buses and its former name “The Silver Line”.

The standard scorecard is more complicated, and includes many other factors as well. The best systems are rated Gold, and so on. We don’t agree with all of the points or categories, but this is a good place to start. The US and Canadian systems (Los Angeles, Eugene, Pittsburgh, Las Vegas, Ottawa) tend to fall into the Bronze Category, though Cleveland’s Health Line makes Silver.⁶⁵

As many people worry, something can be pitched as a high-quality service, and then whittled down by the time of deployment, or afterwards to save costs. Frankly, this can happen with any technology, just look at what has happened to service frequencies on the Phoenix LRT, which dropped to 12 minutes in 2010, but were 10 minutes at opening in 2008, or the Minneapolis-St. Paul Blue Line, which began life with 7.5 minute headways that were quietly retracted to 10 minutes). Clearly, as BRT is developed and deployed, this needs to be monitored. But this is true for any service with net ongoing operating costs that can be reduced over time.

Some findings from the peer-reviewed literature are below. Most, but not all of the evidence is favorable to measurable economic development impacts, clearly every system is unique:

- “Multilevel models reveal BRT improvements prompted property owners to convert single-family residences to higher density apartments and condominiums. Land price premiums of up to

10% were estimated for residences within 300 m of BRT stops and more than 25% for retail and other non-residential uses over a smaller impact zone of 150 m.”⁶⁶

⁶⁶ (Cervero and Kang 2011).

- “First, Seoul’s BRT contributes to increased development density in urban centers, acting as a centripetal force to attract firms from the suburbs into urban cores and supporting arguments for Smart Growth proponents. Second, unlike its redistributive effects on nonresidential activities, the BRT has a limited effect on the redistribution of residential activities, implying that residential locations are less sensitive to accessibility improvements made by the BRT than are nonresidential locations. Third, reflecting the transferred space demands from the suburbs to the urban cores, the CBD reaps the highest property value gains, while all of the outer ring zones suffer from reduced property values.”⁶⁷
- “[T]he BRT system is the favorable component for the location of creative industries and service sectors within 500 meters of BRT-bus stops. In addition, the BRT operation increases the employment density within the same distance to the bus stops by 54%.”⁶⁸
- “The statistical analysis suggests that accessibility advantage conferred by BRT is capitalized into higher property price. The average price of apartments adjacent to a BRT station has gained a relatively faster increase than those not served by the BRT system. The capitalization effect mostly occurs after the full operation of BRT, and is more evident over time and particularly observed in areas which previously lack alternative mobility opportunity.”⁶⁹
- “Results suggest that for every 5 min of additional walking time to a BRT station, the rental price of a property decreases by between 6.8 and 9.3%, after controlling for structural characteristics, neighbourhood attributes and proximity to the BRT corridor.”⁷⁰
- “Properties [in Bogota] offered during the year the extension was inaugurated and in subsequent years have asking prices that are between 13% and 14% higher than prices for properties in the control area, after adjusting for structural, neighborhood and regional accessibility characteristics of each property.”⁷¹
- “The main results showed that, with respect to the value of properties in relation to proximity, the housing market places value premiums on the properties in the immediate walking proximity of feeder lines. The analysis by socio-economic strata

⁶⁷ (Jun 2012). This study uses simulation, rather than empirical evidence, so keep that in mind.

⁶⁸ (Kang 2010).

⁶⁹ (Deng and Nelson 2010).

⁷⁰ (Rodríguez and Targa 2004).

⁷¹ (Rodríguez and Mojica 2009).

showed that middle-income properties were valued more if they fell closer to the system, while there were opposite results for low-income housing. Finally, analysis across time reflects slight average annual increases in property values correlated with the implementation of the system in two specific areas analyzed.”⁷²

⁷² (Munoz-Raskin 2010).

- “In common with other forms of mass transit, a fully-featured BRT has the potential to offer significant effects on land development.”⁷³

⁷³ (Deng and Nelson 2011).

⁷⁴ 300 m.

⁷⁵ 30 m.

- “A property 1,000 ft⁷⁴ away from a station is valued approximately \$9,745 less than a property 100 ft⁷⁵ away, all else constant.”⁷⁶

⁷⁶ (Perk et al. 2010).

- “A key result is that for condo sales that occurred in 2007 or 2009, the BRT premium was approximately 7.6%. For condo sales in 2000 and 2001, prior to the opening of the Silver Line, no sales premium existed for proximity to the corridor.”⁷⁷

⁷⁷ (Perk et al. 2013).

All of this is consistent with general observations and what theory would predict about accessibility improvements. A transport system that adds to accessibility in a significant way warrants a premium in the prices people are willing to pay to take advantage of it.

11.21 Discussion

Like magicians, modern US streetcar promoters engage in diversion and distraction, attributing all urban success to streetcars and covering up the mistakes. The net benefits of streetcars (compared with other, less expensive technologies) are illusory, the costs are real.

Wealthy US cities like their toys: new stadiums, trains, convention centers, and the like are the most egregious examples. If money were free, this would not be a problem. If money were free, it wouldn't be money. Consideration of resources matter in transport design. Constraints (limits on available resources) can drive creative design. But constraints matter, we should not dedicate all of our resources to your pet project because that means there are fewer resources to spend elsewhere. Aside from a few macro-economists, no one believes that money grows on trees. Wealth is created, and the more of our wealth we spend here the less we can spend there. Spending more money on streetcars means spending less on something else.

The notion of ‘permanence’ is in stark contrast with the idea of ‘responsiveness’ that make spontaneous cities work.⁷⁸ Every dollar

⁷⁸ (Levinson 2016b).

sunk into fixed cost is a dollar less available to adapt to changing conditions.

Making large investments now in fixed expenditures to support weak transit lines is a poor use of scarce resources. As the technology environment changes, the types of appropriate investments will change with them, and for the first time in almost a century, we are on the cusp of major technological transformation in transport. The arguments about streetcars will shortly appear to be as moot as argument about canals.

Part III

Cities

Cities and networks co-evolve. While in the short-run networks and land use are given, in the long run both change. The ideas of induced demand, induced development, and induced supply show how networks and land use change patterns. Cities are a solution to the transport problem. They exist to enable access, and are why we cluster. Travelers cause congestion, it is one reason why we regulate land use through zoning. Cities grow (or decline) and then need connections to other cities, which increases the daily interaction areas.

12

Clustering



Figure 12.1: Real estate plexus in Putney, London, England. Note this wasn't the entire complex of local real estate agents clustered in the shopping district of Putney. Photo by D. Levinson

Hank Scorpio: Uh, hi, Homer. What can I do for you?

Homer: Sir, I need to know where I can get some business hammocks.

Hank Scorpio: Hammocks? My goodness, what an idea. Why didn't I think of that? Hammocks! Homer, there's four places. There's the Hammock Hut, that's on third.

Homer: Uh-huh.

Hank Scorpio: There's Hammocks-R-Us, that's on third too. You got Put-Your-Butt-There.

Homer: Mm-Hmm.

Hank Scorpio: That's on third. Swing Low, Sweet Chariot ... Matter of fact, they're all in the same complex; it's the hammock complex on third.

Homer: Oh, the hammock district!

Hank Scorpio: That's right.¹

¹ *The Simpsons* Episode 155 'You Only Move Twice.'

Housing and employment activities are not spread evenly across cities and regions. This is obvious to anyone who has seen a downtown skyline. Downtowns have dramatic skylines because firms want to be there and developers want to maximize the return on their land by building skyscrapers. But not all firms want to be downtown, and not all households want to be in single family housing. This chapter examines the factors that affect location decisions of households and firms, which helps explain how metropolitan spatial structure influences accessibility.

12.1 *Multi-sided markets*

The idea of the two-sided market is best exemplified by eBay. This is hardly a great website (as of this writing), but it remains valuable because it connects buyers and sellers. Buyers are there because vendors are there. Vendors sell stuff there because buyers are there. eBay gets its middleman cut, and better websites can't get a foothold since shifting everyone simultaneously is hard. Many tech companies try to do this. Amazon operates in a similar vein, though it also takes the role of vendor. Uber matches taxi drivers with passengers (but loses money still, and may need to become a fleet operator). There is lock-in because of the two-sided nature of the marketplace and the value to consumers of a variety of suppliers, and to producers of numerous consumers, despite the competitors. Dating services match people seeking contact.

eBay is just the virtualization of a flea market (or shopping mall). Those are physical places where everyone goes to trade. The shopping mall (and parking lot owner) collects rent from the vendors to be able to participate. In some cases they may also collect rent from the shoppers (charging for parking, for instance).

Cities can be thought of as two-sided markets as well. The primary economic function of cities is production.

WE ARE HERE BECAUSE YOU ARE HERE, YOU ARE HERE BECAUSE WE ARE HERE. In this case, it is the production process, rather than (or in addition to) the consumption process that is relevant. Laborers and employers co-locate, people to get jobs, employers to attract workers. Cities (or those who own them, the landowners), if managing this properly, profit from taxes and increased property values. In a democratic context, this is an argument for [land value taxes](#),² since the land value appreciates because of the actions of others.

² §16.

Cities compete with each other, but each has some spatial monopoly aspects as well. They also have specialization. Los Angeles for instance specializes in film-making among other things. Everyone is there because everyone else is there. It's not impossible to make movies elsewhere, yet many if not most are made in greater 'Hollywood.'

Each film producer is also a multi-sided market, connecting all the elements of film production (writers, actors, set-designers, directors, sound production, cameras, editing) and distribution, which are otherwise largely independent individuals and organizations that come together to create art and entertainment, and then disband. As such, producers have power over the system in their coordinating function. Though technically anyone could put together a team, a producer has connections that cause people to believe that he (or she) will put together a more artistically and remuneratively successful team, and thereby attract people to want to be part of it. Success breeds success and power.

Universities establish several multi-sided markets. Students and professors are matched. In the modern world, students don't directly pay the professors, it is mediated by the university. If we can go back in time, we can imagine the professors paying rent to the university to have the privilege of teaching, and collecting directly from students.³ Instead universities commodified teaching and turned professors into laborers.

³ As professors, we do not advocate this idea.

Researchers and funders are mediated by universities as well. You can't be an independent professor and expect to get funded by science agencies in the modern world. This is mediated by universities and similar organizations with Sponsored Research Offices.

Perhaps the most cynical relationship intermediates between students and employers. Students come to the university to learn and get a degree, but also become certified as employable, and to get some assistance in finding work (access to job fairs is baseline for this, some schools, especially business schools, go much farther in assisting job placement). So the university is selling itself to students as a place where they can get a first job, and they are selling themselves to employers as a place where they can find labor. In fact universities often speak of training the workforce, as if finding a job with a large organization (as opposed to becoming an independent entrepreneur who starts new companies, or helping the non-profit sector, much less a well-educated human being) is the goal.

Power accrues to the middleman. Most power comes from being the middleman in a difficult-to-disintermediate multi-sided market. Everyone agrees you have power because of common rationality of beliefs. If everyone thinks that everyone thinks you have power, then you have power, because changing everyone's beliefs simultaneously isn't just hard, it's the veritable herding cats.

People feign loyalty to powerful individuals. Many want to appear to be loyal. Society rewards that characteristic, as someone who exhibits loyalty to someone else might be loyal to me. They may even feel loyal (as what better way to appear to be loyal than to actually be loyal). But in the end almost all who claim loyalty will leave when the going gets tough. They will 'defect' in game theory terms if they believe that serves their long term interests, like rats fleeing a sinking ship. Likewise, if no one believed you have power, then you wouldn't. We could act against you and no one would back you. Cities try to exploit feelings of loyalty with municipal pride, sometimes centered on sports teams or unique food.

So today, the President of the United States has power because enough people continue to agree that the President has power, independent of that individual's capacity for the role. If instead the President were continuously disobeyed by staff and the federal government, the President would not have any power. The risk is that this would bring the whole system down, and people are (rightfully) nervous about the unintended consequences. Revolutions have a mixed history. But the ability to grant power is in our collective selves, and we can choose to not grant it. Consent of the governed is an important concept, but the difficulty of displacing the lock-in of multi-sided markets should not be underestimated.

12.2 *Clustering and economic development*

The chapter's opening quote from the long-running television series *The Simpsons* nicely illustrates the clustering of similar retail activities. Why would hammocks cluster in the hammock district? Might they not get more business if they were spread across town, closer to the butts they hope to rest? By clustering together, Swing Low, Sweet Chariot can capture business meant for Hammocks-R-Us. Customers benefit from the variety and price competition in the district and will avoid the random hammock shop over in Shelbyville.⁴

It's not like customers need hammocks daily, so the travel costs are relatively unimportant compared with the benefits of easy

⁴For a more academic view on retail clustering, see (Huang and Levinson 2011).

comparison shopping and thus competitive marketing. Suppliers can serve multiple businesses on a single trip, and so offer lower costs to the hammock shops as well. We see districts like these all over, from scenes of realtors in London, where 11 different real estate agents are all next to each other on the local High Street in Putney, to the KitchenTown neighborhood in Tokyo, where restaurants can get all their kitchen equipment. Even cities specialize: in the United States finance clusters in New York, computer technology in Silicon Valley, medical devices in Minneapolis, as a few examples.

Clustering is a complex phenomenon, occurring at scales from the street, to the neighborhood, to the municipality, to the metropolis, to the nation, and across nations. It occurs in residential, retail, and production sectors. It also occurs differently in different production sectors of the economy. We discuss those issues in this chapter.

Standard urban economics describes Economic Base Theory. Tim Chapin gives us a useful definition:⁵

⁵ (Chapin 2008).

The economic base technique is grounded in the assumption that the local economy can be divided into two very general sectors: 1) a basic (or non-local) sector or 2) a non-basic (or local) sector.

Basic Sector: This sector is made up of local businesses (firms) that are entirely dependent upon external factors. For example, Boeing builds and sells large airplanes to companies and countries located throughout the world. Their business is dependent almost entirely upon non-local firms. Boeing does not sell planes to families or households locally, so their business is very much dependent upon exporting their goods. Manufacturing and local resource-oriented firms (like logging or mining) are usually considered to be basic sector firms because their fortunes depend largely upon non-local factors, they usually export their goods.

Non-basic Sector: The non-basic sector, in contrast, is composed of those firms that depend largely upon local business conditions. For example, a local grocery store sells its goods to local households, businesses, and individuals. Its clientele is locally based and, therefore, its products are consumed locally. Almost all local services (like drycleaners, restaurants, and drug stores) are identified as non-basic because they depend almost entirely on local factors.

Economic development practice is to entice/enhance ‘basic’ industry. The example of Boeing is especially timely, given the recent issue of Boeing potentially moving airframe production if it didn’t get labor givebacks. Most of the places to which Boeing was considering moving do not already have an airframe sector, or upstream or downstream vendors or customers, or a workforce skilled in airframe manufacturing, which would generate benefits

beyond ‘jobs, jobs, jobs.’ Similarly, economic development advocates often argue for new infrastructure, despite at best weak evidence that in a mature (road, rail, transit) network there will not be much accessibility gain, and thus little resulting economic development. Another Seattle company has had a similar story. The bidding war for Amazon’s second headquarters, HQ2, was all about metropolitan economic development.

The key point from welfare economics is that everything is non-basic at a global level, and everything is basic at the household level. While it might be locally preferred to have more basic employment (we get money in exchange for stuff), that makes no difference on the global scale. Economic development practice is parochial – so it is no surprise that it is funded by place-based local and state governments.

WE SHOULD THINK ABOUT ‘SECTORS WITH SPILLOVERS.’ Yet that is not to say that local development is neither good nor bad. The reason it might actually be better to have local concentrations is because of various types of economies: in particular economies of scale of various kinds (including economies of agglomeration, which in places with very large employers, may all be internalized), and network economies. These economies produce spillovers, not just for the firm, but also for upstream and downstream suppliers and customers, and potentially for competitors as well. We call these *spillover sectors*.

Economies of scale are so pervasive we don’t notice them. Every road is an instance of economies of scale, we walk/ride/drive along roads because it is faster than going across unimproved space, even though it is less direct, but we individually could not afford to build the road, so we share the fixed costs with lots of people. The cost per person for roads is lower the more persons we spread the cost over. Economies of scale may also be played out (exhausted) at the margins we observe. Just because we had economies of scale in the roads we have built to date does not mean there are still economies of scale waiting to be picked up off the street like the proverbial \$20 dollar bill.

Two economists are walking down the street when one points to the ground and says, “Look, a \$20 dollar bill!” The second economist replies, “That’s crazy. If that were a twenty dollar bill someone would have picked it up already.”

In fact, most of the easy things with regards to transport have been done. We picked the the projects with the highest benefit/cost ratios (BCR) (low-hanging fruit) first, and worked our way down the list (up the fruit tree), until the cost of building the project outweighs

the benefits (the cost of getting the fruit outweighs the benefits of consuming it). Clearly new projects are often on the low BCR side of the equation.

Network economies mean that the value of something increases the more people who use it. These are also so pervasive we don't always notice them. The more people who use the local airport, the better the airport is for a resident, because it will have more flights. Roads are also examples of network economies, as the more people who use the road, the higher quality road we will build and the more accessibility (by auto) we each have. Thus we have Interstate highways because we have hundreds of millions of drivers. If there were only one driver, even Amazon founder Jeff Bezos,⁶ we would not have an Interstate system.

⁶ One of the world's wealthiest people.

Within the context of types of employment the considerations for economic development should not be Basic vs. Non-basic. Rather, the concern should be about employment that has benefits from concentration, either economies of scale and agglomeration, or network externalities, or both, and then work toward establishing concentrations of those sectors to maximize the benefits to society. This usually means considering where local strengths already are, rather than starting from scratch. Complement the existing rather than dropping in an alien business. The job multiplier from two jobs paying \$75,000 may be the same, but the one in a spillover sector will lower costs for others in the sector and/or improve benefits. From a policy perspective, this means not going after projects just because they generate jobs, but encouraging firms to relocate into specialist concentrations where there are spillover benefits from those concentrations.

In contrast, sectors which have losses with concentration (think natural monopolies, where competitors split the market so that no firm can recover fixed costs), should be encouraged to remain dispersed.

CITIES ARE POSITIVE FEEDBACK LOOPS IN SPACE. Cities exist only because it is more valuable for people and organizations to be near each other than far from each other. Does density create agglomeration economies or do agglomeration economies create density?

Certainly evidence shows cities with greater density also produce greater 'wealth' per capita. In *Triumph of the City*, Ed Glaeser argues it is about the speed of the spread of ideas, in addition to the classical reasons about transport costs for people and goods.⁷ However cause and effect are not clear, nor necessarily independent.

⁷ (Glaeser 2012).

Consider our contrary hypothesis:

*Cities with firms that are more agglomeration-benefiting (i.e. firms in sectors with spillovers) produce higher densities; cities with firms that are less agglomeration-benefiting produce lower densities. In other words, density is the effect of agglomeration economies, rather than the cause of agglomeration benefits.*⁸

⁸ The agglomeration-benefits of an industry change over time, and are more important when an industry is young, and in the growth phase than when it is old, mature, and locked-in.

This hypothesis implies, for example, that increasing densities in Phoenix will not suddenly make Phoenix more productive because the firms in Phoenix don't benefit much from the additional clustering (and disbenefit from the negative externalities of density such as crowding, pollution, congestion, and the higher costs of services and land that accompany high density). Some industries (finance, government, media) value the connectivity provided by accessibility more than others (agriculture, large scale manufacturing), and so are more likely to cluster together. It turns out, these are also presently the faster growing industries in the economy. Cities like New York, Toronto, London, Auckland or Sydney, in which the finance industry (among others) locates, or Washington, Ottawa, Westminster,⁹ Wellington, or Canberra in which the government industry locates, benefit more significantly from the daily walking distance, face-to-face interactions possible by agglomeration.¹⁰ Even in those capital cities there may be limits to agglomeration such that the marginal benefits of an additional person or job may not outweigh the marginal cost.

⁹ The City of Westminster and the City of London were once distinct places. They are still separate boroughs in greater London.

¹⁰ (Storper and Venables 2004).

Unfortunately, the spatial location rules that help the finance industry be more productive (concentrate everything in Manhattan, Toronto, Sydney, Auckland, or London) do not necessarily generalize to other industries or other cities. Those other cities just don't get as many financial headquarters and offices, and don't see the growth in those sectors, won't pay as high a premium for accessibility, and aren't as dense. Similarly, within metro areas, the old, dense, downtowns retain the regional financial, legal, and government headquarters while the new suburban areas that don't value the propinquity get less, since the density is costly and the benefits for those in certain sectors is small.

¹¹ Despite economic correlations suggesting otherwise – correlation is not causation.

Moreover, density of itself does not create growth¹¹ or lead to more productivity without a useful transport system. This is why fast growing areas are auto-oriented in many places, cars are faster than transit under many land use pattern/road network configurations and connect to more places in less time. As we note [earlier](#),¹² accessibility is the product of both density and speed, how much one can reach in a given time. Certainly density helps increase accessibility to a point (where the benefits of more people

¹² §1.

are outweighed by the congestion/pollution costs, etc.), but so does a faster transport network. At the point where connecting by personal transport fails, mass transport may be appropriate, and is certainly necessary for very large conurbations like New York.

There is also the inter-firm vs. intra-firm spillover argument. Many large firms, like universities and hospitals, build campuses to internally capture the spillovers from the random contacts that accessibility brings. This might lead to less vibrancy and turmoil in the market sector, as there are fewer independent actors competing, but it is also a natural stage of development from birth to maturity in sectors. To obtain economies of scale, firms consolidate, and fewer and fewer firms capture more and more market share. Ultimately gales of creative destruction come¹³ and the stagnancy of the few firms leads to their own demise, but that is the natural order of things. If firms could never capture their downstream profits by growing large, no one would ever invest. After all, the first few years are much less profitable than those after the monopoly/oligopoly has been established. And *capitalism* is not about free markets and free trade, it is about profit – not that there is necessarily anything wrong with that.

¹³ (Schumpeter 1942).

There are thus natural cycles. Firm formation is naturally higher in some sectors, in some periods, and in some places, than others. But the successes of dynamism lead to consolidation. Increasing density exogenously (or removing some regulatory constraints in a few places where they are binding) has very little to do with this.

Since there can only be one national capital per nation,¹⁴ and perhaps one financial capital per nation, the opportunities for creating financial mega-cities of the order of New York, London, Toronto, Sydney, Paris, Tokyo, etc. are limited; second order cities will not magically become first order just by increasing their density.

¹⁴ We are aware of countries with multiple capitals (Wikipedia contributors 2018e), but this is exceptional. We are also open to having multiple capitals, or at least spreading the functions of the single capital across the nation.

To take a case we are familiar with, Minneapolis, downtown has not seen much new commercial growth in over a decade (a few new official buildings in Downtown East mostly relocating existing employment), though there has been a significant (though regionally relatively small) increase in residential density. Minneapolis might be termed a provincial capital. It has a large hinterland, one of twelve US Federal Reserve Banks, many regional and national bank operations (Wells Fargo, US Bank, etc.), and a large number of headquarters of large firms (though many are not downtown: Target, Best Buy, General Mills, 3M, Medtronic, etc.), as well as emerging clusters in a few economic sectors.

While Minneapolis, much like other US cities, has seen significant residential development in the past decade, and limited

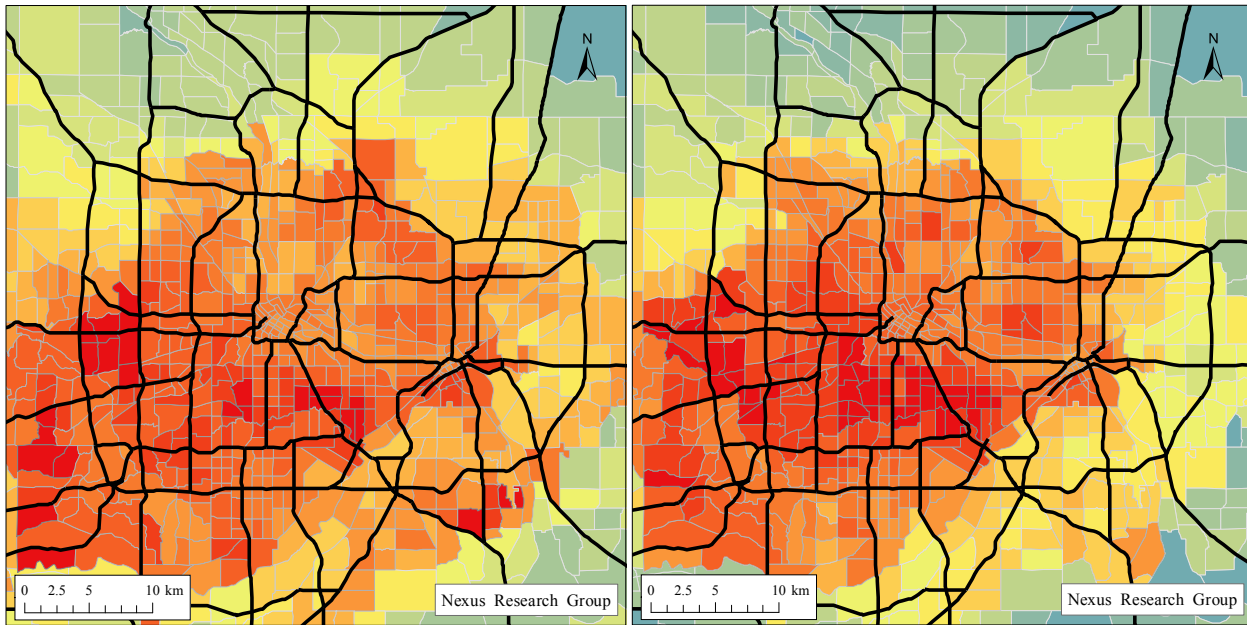


Figure 12.2: Balance of Accessibility to Jobs and Workers in (a) 1995 and (b) 2005 in the Twin Cities (ratio of jobs reachable in 20 minutes to workers reachable in 20 minutes by car from residences in the morning peak: 7:30 to 8:30 am). Red indicates jobs in excess of labour, blue-green indicates labour in excess of jobs. Yellow is balanced. Balance improved in this period. (Levinson et al. 2017).

commercial investment, in downtown there remains plenty of underutilized land (i.e. parking lots) for development to occur, and no real constraints on new office (or residential) construction. Clearly the private benefits of building downtown are not as great as locating their new building in the suburbs (or elsewhere) to the firms making those location decisions. Unlike New York City, zoning in downtown Minneapolis is not generally a binding constraint. In brief, the private share a suburban-locating firm attains from agglomeration benefits from the central business district (CBD) do not outweigh the costs, (including the opportunity cost of building in some other locale). Suburban places too have some (weaker) agglomeration benefits, and those may be sufficient, or are at least perceived as sufficient by developers and firms. The location within a metropolitan area still produces benefits (which are weaker than the CBD benefits on daily walking distance face-to-face metric, but still enable daily or weekly driving distance face-to-face), such as shared labor pools.

Though there are agglomeration benefits of locating downtown, they are not sufficient on their own to attract firms. So local communities, acting through local government, offer incentives to these non-CBD locating firms to move downtown to enable those spillovers. As an example, in 2018 the Arizona Republic published

an investigative story about the use of tax breaks in Phoenix and Tempe, and showed that not only did the City of Phoenix not do any sort of cost-benefit analysis for the largess, but the tax breaks offered to new development increased the tax burden on existing properties proximate to the new developments, and reduced the amount of property taxes going to local school districts.¹⁵ These examples show how fraught this sort of tax base chasing is, and how potential public agglomeration gains can be captured or squandered.

¹⁵ (Philip and MacDonald-Evoy 2018).

12.3 *Constraints drive growth*

DO CITIES WITH CONSTRAINED REAL ESTATE GROW BECAUSE OF, OR DESPITE, THE SCARCITY OF LAND? All land is scarce as we don't really make any more of it.¹⁶ Cities with scarce land have geographic constraints such as oceans, mountains, or other such limits to buildable areas. Coastal cities are more economically productive.¹⁷ In contrast, the Twin Cities or Phoenix are able to grow spatially concentrically with few natural obstacles. The economic growth of many cities with scarce land such as San Francisco, New York, Seattle, Vancouver, or Mumbai raises a question: Did those cities grow despite the scarcity of land, or because of it?

¹⁶ We are aware of the concept of landfill and the Netherlands, so while there are exceptions where people do make more land, these exceptions do prove the rule.

¹⁷ (Rappaport and Sachs 2003).

On the one hand, consider the cause of the scarcity of the land, the body of water on which these cities grew. That water provided essential access to the rest of the world by shipping, and was critical in the formation of many harbor-centered cities. So while the constraint of water exists, it is a necessary feature of any city which wants international water-borne trade.

The US has seen a decline of river-based cities (Cincinnati, St. Louis) and a rise of container shipping-based cities (Los Angeles, Hampton Roads).¹⁸

But perhaps the rise of constrained cities is not just because of the accessibility to the rest of the world system that the constraint provides, but also because of the internal accessibility that the constraint forces.

Imagine two nascent towns, with equal harbors and otherwise identical. *A* has a plethora of land and is essentially unconstrained while *B* is on a peninsula. As they grow, *B* eventually becomes spatially confined as the peninsula is filled up. *B* becomes denser than *A*. Does it, as a result, grow faster or slower? If there were positive externalities, such as economies of agglomeration that

¹⁸ Chicago is a special case, where the water not only provided shipping (and Chicago trans-shipment from the Great Lakes system to the Mississippi River system), it created a barrier which channelized the railroads through Chicago, so that it was a natural point on east-west railroads in the northern half of the United States.

result from the increased accessibility, it might grow faster, despite providing fewer choices to potential locators and having higher costs for land.

¹⁹Jarrett Walker at Human Transit notes "There's an additional factor. Constrained sites are spectacular sites. The natural features that constrain cities are almost always things that we value as scenery. Isn't this an independent factor to the overall scarcity of land in a constrained city, such that we should expect the impacts of physical constraints to be 'squared' or in some sense steeper-than-linear?"

SPATIAL CONSTRAINTS ACCELERATE THE URBAN FEEDBACK LOOP.¹⁹ Why locate anywhere but to be near something or far from something? Cities offer opportunities to be near many things (people, shopping, restaurants, employment, etc), and as cities exist, those things must be of value to the people who locate there. By locating, people add to the 'stuff' others can reach.

Accessibility is a measure of nearness to things: How much stuff you can reach in T minutes time? Which stuff matters and how much time is acceptable depend on individual preferences, but these can be measured and observed. An area with higher density enables you to reach more stuff in less time because it is physically closer, even if the network is slower (you can move less distance per unit time), provided the density increases at a rate faster than speed decreases.

As noted above, some cities are physically constrained. In fact, the five densest cities in the US (New York, San Francisco, Los Angeles, Honolulu, and Chicago) all have some significant physical constraints (island, peninsula/bay, mountains/ocean, island/mountains, lake) hemming them in.²⁰ Australia's Sydney is famously built around the world's most beautiful harbor, and is constrained by the Pacific on one side, and will be limited by the Blue Mountains on the other as it grows. Not surprisingly, these are among the most expensive cities in which to live. This indicates that the location is especially valuable, because of the accessibility benefits it provides. Harbors offer accessibility to trade routes, which can be analyzed the same ways as local accessibility, though have obviously different policy implications. In modern times, access to harbors is important for freight but access via airports is arguably more important for global access for people.

Consider the hypothesis that the constraint itself creates value. Because of the constraint, more people and firms are bidding for scarce space (since the non-scarce, non-centrally available space has a much higher transport cost (across the bay, off the island, in more distant suburbs) driving up rents. As a consequence, developers build at higher density in the core city, increasing accessibility. The higher accessibility creates value for residents and businesses, leading to even higher rents. Location has positive spillovers.

Higher density increases accessibility if the change in density outweighs the reduction in travel speed due to congestion. For

²⁰ Not all constraints are natural. Urban growth boundaries can artificially raise the cost of land by limiting where developers can build. These constraints are bad policy when they are coupled with restrictive zoning which then limits how much developers can build.

instance, a recent study of San Francisco found that proximity is a better factor explaining access than driving speeds.²¹

²¹ (Thomas et al. 2018).

Accessibility improvements through increased density can be achieved where either the existing transport network is well under capacity (so adding demand does not noticeably alter travel times), or where a new network is built that has adequate capacity (as in a grade-separated transit network built to serve a high density area).

Whether the benefits of increased accessibility outweigh the costs depend on the costs of congestion or the costs of a new transport network to serve the higher density.

This accessibility has value (agglomeration economies), and places with the highest accessibility attract firms that most value the agglomeration, so industry sorts into those for which accessibility has higher value (which locate in the center) and those for which the accessibility benefits do not outweigh the combination of congestion costs and higher rents, which locate where both rents and transport costs are lower.

Accessibility is a normal good, so more is better and demand increases with income. If we have these two cities, the denser, more accessible city will attract more development, and thus become larger, and because land is scarcer, land prices will be bid up.

12.4 *Simpli-city*

HIGH-RISES ARE FUNCTIONALLY CUL-DE-SACS IN THE SKY. Without skyways connecting them, high rises are isolated structures that don't add any more to access than a cul-de-sac off the main road. Travel within the building (*cis*-port, rather than *trans*-port) imposes an equivalent cost, and from a high floor on one building to a high floor on another requires walking to the within-building public transport system (the elevator), waiting, boarding, traveling, stopping for others to board and alight, and then exiting the elevator at the ground floor to leave the building, and then repeating the process in reverse once the destination building has been reached.

To illustrate the point about height limits prospectively adding to accessibility rather than reducing it, we provide a simple model of a city, which we label *Simpli-City*.

This is a linear model for convenience, it has length and height, that is, it is only one block wide, so it is 2-dimensional. A planar city (3-dimensional, with x , y , and z coordinates) will give us the same

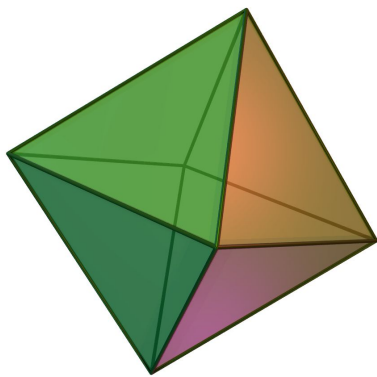


Figure 12.3: The Octahedron is the accessibility maximizing shape in a 3-dimensional 90-degree grid, where the street grid is at right angles, and every floor of every building is connected with its 4-immediate neighbors by skyways.

kind of results, though obviously the numbers would vary, and the illustration more complicated.

Simpli-city has demand for, say, six block-floors worth of development, how should it be organized?

At one extreme, Simpli-city can be a strip and be six blocks long. At the other, it can be a single block and be six stories high. It turns out these two extreme scenarios are equivalent in the accessibility they provide if we assume inter-floor distance within the building is the same as inter-block distance between buildings. You can modify this assumption depending on width of roads and speeds of intra-building travel, but the general point remains. This is because they are topologically equivalent. Topological equivalence means the shapes are the same if you deform them by stretching, crumpling, or bending, but not tearing or attaching. A six-story long city is the same as a six-story tall city on its side.

But there are a number of topological variations in between which might be more efficient.

If we want to maximize access, we want to minimize the total travel time (equivalent to walking distance) between blocks.

In the six block-floor sized example, Scenario 6b: The Tent, with 2 one-story buildings at the edges of town and 2 two-story buildings in the center of town, minimizes total travel time, as shown in Table 12.1. A few other configurations are also better than the worst cases shown here (the strip and the tower). One can imagine other scenarios, such as those which leave empty blocks between buildings, which we might call sprawl, would be even worse from an accessibility perspective.²²

So adding height increases access up to a point, but there is a point where it is better to build out (at the edges) rather than add to the top.

Without skyways, each building is a cul-de-sac. Skyways can increase access, as illustrated in the table summarizing a variety of scenarios.

We know from geometry that a sphere maximizes the volume available within a surface area. So the sphere maximizes accessibility if there were no network, but this is complicated by the topology and structure of the network and the presence or lack of skyways between buildings above ground level. Cities are organized around networks. We know that on a planar 90-degree grid network, a diamond-shape defines an isochrone.²³

²² (Levinson 2016a).

²³ (Levinson and Krizek 2017).

Layout	Scenario	B	C	C_S	$C/(B^2)$		B	A	A_S	S	A_S/S
1	1	1	0		0.000		1	1.00			
1-1	2a	2	2		0.500		2	3.85			
2	2b	2	2		0.500		2	3.85			
1-1-1	3a	3	8		0.889		3	8.40			
3	3b	3	8		0.889		3	8.40			
2-1	3c	3	8		0.889		3	8.40			
2-2	4a	4	20	16	1.250	1.000	4	14.52	14.79	1	0.273
1-2-1	4b	4	18		1.125		4	14.65			
1-1-1-1-1	5a	5	40		1.600		5	22.10			
1-2-2	5b	5	36	32	1.440	1.280	5	22.35	22.62	1	0.273
1-3-1	5c	5	36		1.440		5	22.35			
1-1-1-1-1-1	6a-0	6	70		1.944		6	31.01			
6	6a-1	6	70		1.944		6	31.01			
1-2-2-1	6b	6	58	54	1.611	1.500	6	31.75	32.02	1	0.273
3-3	6a-2	6	70	54	1.944	1.500	6	31.01	32.30	2	0.641
2-2-2	6c	6	62	50	1.722	1.389	6	31.50	32.30	2	0.399
1-3-2	6d	6	62	54	1.722	1.500	6	31.50	32.02	1	0.525
1-4-1	6e	6	64		1.778		6	31.38			
1-2-1-1-1	6f	6	64		1.778		6	31.38			
1-2-3	6g	6	64	56	1.778	1.556	6	31.38	31.90	1	0.525

Where: A is access, A_S is access when skyways are present, B is number of blocks, C is total cost of travel in the city without skyways, C_S is the total cost of travel in the city when skyways are present. Accessibility is computed using a gravity model formulation of accessibility, where θ the impedance parameter is set = -0.08 . Each row is a Scenario. The first column indicates the layout of the city, so 1-1 (scenario 2a) means there are two adjacent blocks, each with buildings one-story tall. Similarly, 1-3-2 (scenario 6d) means there are six block-floors, the westmost block is one story tall, the central block is 3 stories tall, and the eastmost block is two stories tall. In the variation with skyways, all blocks that can be connected via skyways are connected, in this case, the second story of the central and eastmost blocks have a skyway connection. The **bold** numbers indicate the scenario with the maximum access for the particular city size.

Table 12.1: Summary of Results from Simpli-city Model.

²⁴ Best known to Dungeons & Dragons players as an eight-sided die.

In 3-dimensions, on a 90-degree grid network with skyways connecting every floor with buildings to the north, south, east, and west, it turns out that an octahedron (as shown in [Figure 12.3](#)) (two four-sided pyramids attached at their base)²⁴ is the access maximizing shape. This implies a city floating in space perhaps, or a building with a large underground pyramid mirroring the above ground pyramid. The underground space will likely have lower rents than the above ground space due to less natural sunlight.

Identical access can be achieved with different topologies. Things that were topologically not equivalent without skyways may become topologically equivalent with skyways, and vice versa.

If height limits (vertical constraints) add to access under some circumstances, so that for instance, a single six-story building produces less access than two 3-story, or three 2-story, buildings, it should not take much convincing the same happens horizontally. The Simpli-City model also demonstrates that constraints forcing cities up rather than out can add to access. This may explain the premiums experienced by topographically constrained cities above and beyond simple scarcity of the land. The greater intensity of land use produces positive spillovers (from both greater productivity and more consumption amenities), at the cost of higher land prices.

12.5 *Beyond density*

IF THE MARKET WANTS DENSITY, SHOULD THE MARKET GET DENSITY? We like density. This is a personal preference. Being mostly (small 'I') libertarians, we feel no need to impose this on others. If lots of people like density, they should create dense places, or hire developers to do this for them. Or developers, sensing this preference with their nose tuned to profit, can speculatively build density. If people are more productive in dense places and earn more money, or are more consumptive and get more value for money, they are even more induced to create more density. However, as we claim above, the most important part of this argument is backwards. The primary causality is that cities (metropolitan areas) with growth create density as people and firms are attracted to faster growing areas. Take away the growth and leave the built infrastructure, and even the people, and you have a decaying city that slowly (or quickly) depopulates.

To be pedantic, and establish clarity, the population density of the earth, the United States, Minnesota, etc. increases over time if population increases and land area does not. The density of

suburban areas tends to increase over time as they are transformed from farms to not-farms. Local density may decrease as cities of fixed boundaries depopulate. Part of this problem is the fixity of boundaries, part is consumer's desires as shaped by markets and policies to consume areas with locally lower density.

But when people complain about something becoming too dense, they don't usually mean building more places at the same average density, they mean increasing the density of existing places, that is, intensifying development. While some community groups oppose all new development under any conditions, we are all for fewer regulations to allow more development, so long as negative externalities²⁵ associated with density (congestion, pollution, parking spillover, etc.) are properly internalized. The lack of clear property rights, road pricing, parking pricing, pollution pricing, etc., however, has led communities to develop a regulatory rather than pricing approach, which we discuss in [Zoning](#).²⁶

²⁵ §7.

²⁶ §13.

12.6 *Competing centers*

"The filling-up of America so that you can no longer build a detached single-family house within half-an-hour's driving time of the interesting places people want to be, and the consequent rise both in current location premia and expected future location premia." – Brad DeLong.²⁷

METROPOLITAN AREAS SHOULD HAVE COMPETING URBAN CORES. We argue that communities and developers should create new places where people want to be, i.e. if all the current good places are taken (and too expensive in terms of time and money), then create new good places where land is cheaper, either suburbs, satellite cities, or make other existing places 'good.' If there were, in fact, demand, a premium to be paid by real estate consumers for such places, it would be a matter of coordination to create new precincts, or extend existing areas, so that they become interesting. Economies of agglomeration, while they still exist, are clearly not what they used to be, and downtowns are far less important. Managing the positive feedback loop that are cities/real estate/accessibility is no easy trick, but it takes a special kind of elitism to think that 'interesting places' to use the term from economist Brad DeLong in the quote above are inherently limited to a few large cities with long commute times.

In the 2000 Census, the most recent available when DeLong was writing, only three cities had an average over 30 minutes (New York, Chicago, and Philadelphia) though another few come close.

²⁷ (DeLong 2008). "[T]he traffic which is bad everywhere anyone wants to be." (Yglesias 2008). See also the argument that congestion is a measure of urban success (Taylor 2002).

²⁸ We need to distinguish between 'cities' as in 'central cities' or 'municipalities' and 'cities' as in 'metropolitan areas'. In the US context these are generally not the same. Even then, 'city' as 'municipality' means something different when we think of high density urban cores vs. low density, suburban, single-family home neighborhoods. Some urban neighborhoods are located outside the primary central city. To add more confusion, Australian English uses the word 'suburb' to mean a subunit of the urban complex, that is, a neighborhood or district, rather than as a lower density area outside the traditional city. Fortunately Australians do understand the concept of 'suburbia'.

²⁹ (Glaeser 2012).

³⁰ (Leinberger and Alfonzo 2012).

³¹ (Ostrom et al. 1961).

Cities²⁸ are asserted to have economic value,²⁹ and they must, else they would not exist. Walkable neighborhoods within cities are asserted to have economic value,³⁰ and they must, else they would also not exist. If those values include spillovers, that might justify subsidy for the greater good, as they will not be sufficiently supplied. Who should provide that subsidy? Do they produce spillovers?

People 'vote with their feet,' an idea formally known as the Tiebout Hypothesis.³¹ So if one municipality is not providing the desired services, people can relocate. There are often many suburbs, so this is not a problem for those who desire suburban living.

The problem is that the urban cores are monopoly governments in most metropolitan areas, and in areas that once had competition (such as New York) annexation combined them. The issue is the merits of competition in inducing innovation, reducing costs, increasing monitoring, benchmarking, etc. vs. the merits of economies of scale (so New York City might be more efficiently governed if Manhattan and Brooklyn are under one umbrella, or the City of Westminster and the City of London, or Minneapolis and St. Anthony, and so on. But even New York City has Newark, New Jersey as competition; Washington, DC has Alexandria and Arlington, Virginia, or Bethesda and Silver Spring, Maryland as alternatives; Philadelphia, Pennsylvania has Trenton, New Jersey. There are many older cores, which not as dominant as the main city, and perhaps not as 'interesting', but still attractive and redeemable places with good urban bones.

Just as we have competition among lower-density suburbs, we need competition in urban municipalities, like say, the Twin Cities, (or the Bay Area of San Francisco, Oakland, and San Jose) which enable people who want to be urbane to live in one of two or three or more urban cores, and to choose one which has the best mix of taxes and services and amenities and jobs.

Whether two or three cores is enough remains an open question, but this gets back to the point that more such places should be created, and would be if market demand were sufficiently great that developers could compromise with opponents by offering side payments.

13

Zoning



Figure 13.1: Washington, DC - near Union Station. Photo by D. Levinson.

Zoning has few friends these days. It has been criticized by many of a libertarian bent as denying individual property owners the right to do what they want with their property. It has also been criticized by market urbanists who declaim the damnably high rents¹ induced by hard density caps enabled by zoning, and argue caps have diminished economic productivity for the whole country. We are of a libertarian bent and we like density, so why do we, in principle, think zoning is a useful concept?

¹ (Yglesias 2012; Avent 2011).

13.1 Zoning tries to solve the externalities problem

² See R.E.M.'s 'Fall on me.'

³ §7.

⁴ (Coase 1960).

⁵ §8.4.

⁶ (Pigou 1920).

⁷ We are in the second best world of (Lipsey and Lancaster 1956), and while there are good changes that we advocate that will move us to the first best, activities which make one set of parties worse off without compensation, but only locally, without changing the system as a whole, are naturally perceived as unfair and thus face political resistance.

⁸ Alain Bertaud effectively argues that planners just don't know urban economics, and don't even try markets, so there is lack of knowledge and effort as well. (Bertaud 2018).

⁹ Identifying sources of land and water pollution is usually more straightforward.

¹⁰ Euclidean zoning is so-named for the Village of Euclid, Ohio, which implemented zoning in a case that was upheld by the US Supreme Court (Wikipedia contributors 2018j).

¹¹ Tacit rules exist. For instance, see the idea of the parking chair, which in some snowy cities marks on-street parking spaces that have been shoveled by neighboring residents (Wikipedia contributors 2018h).

BUY THE SKY AND SELL THE SKY.² Economics talks about negative externalities,³ where the outcome of a transaction between two parties that negatively affects a third. The classic example is air pollution. A has a factory making parts for B, but the factory pollutes the commons (the air), and C is harmed. The best theoretical solutions are either to have enforceable property rights (eliminating the commons),⁴ or establish appropriate prices for pollution,^{5,6} or to somehow internalize the costs by having the same person control both the production and consumption of the externality (the pollution and the air). Since we neither buy nor sell the sky, nor even rent it, we must look for some other alternatives.

BUT REGULATE THE LAND. Regulation is a second best solution.⁷ Zoning, like other regulations, aims to achieve what could not be achieved through property ownership or monetary prices. Those solutions often fail for a variety of reasons, but the dominant is transaction costs.⁸ It is not costless to impose prices, and it is often impractical to create enforceable ownership of commons like the air. Even if there are clear property rights, enforcement might be expensive if it must go through the court system. Try to prove whose air pollution made you sick and you can see the difficulty.⁹ Nuisance law effectively moved from the courts to regulation with Euclidean zoning to avoid the large transaction costs and uncertainties of the judicial system.¹⁰

ZONING GENERATES ECONOMIES DUE TO EXTERNALITIES. Zoning is a specific form of regulation aimed at restricting certain land uses in certain places, because of the negative externalities they create that are difficult to address via property rights or prices. While historically these externalities were flying shards of rock from gravel pits, more recently zoning defends against are air pollution, smells, litter, street congestion, on-street parking, and other public service crowding. One might argue whether some of these items are truly externalities.

No one has a legal right to the on-street parking in front of their home (unless there is a permit system).¹¹ But the custom, established by decades of practice, gives them that expectation. Even if these are not 'technical externalities,' they are still 'pecuniary externalities.' Upzoning drives up effective costs in markets (or commons) for road space, parking space, park space, school enrollment space, etc. by

making that space scarcer. That some or all of these ought to be private goods is not a relevant rebuttal, as they are not now private goods, and until they are (and maybe after) the losses remain.

MEET THE NIMBYS. Nick and Nora Nimby¹² live near an apartment building. They don't want more development than they bargained for. When they bought their current house, there was a set of laws on the books regulating development on other properties, ensuring it would all be single-family housing. While legally, Nick or Nora Nimby don't generally have a property right in someone else's lack of property rights, the Nimbys do have an expectation of policy continuity, and paid something for that expectation when they bought their home. When someone else tries to rezone property, (or the government proposes it), that may produce economic harm to the Nimbys. They may suffer more local air pollution, more malodorous neighbors, more broken beer bottles on their front lawn from inebriated friends of the nearby youthful renters who are otherwise undoubtedly good people (except when they themselves are drunk at 2 am on a Saturday morning), more traffic on the roads (and thus more time in traffic), more strange cars in front of their house, more crowding in public schools, lowered property value,¹³ and so on. While there may be great social benefits to this arrangement, either through lowered costs of public service delivery or greater economic productivity associated with the huddled masses, there are quite likely higher private costs similarly associated for the Nimbys.

It is not enough that everyone might be better off. Unless some form of compensation is given to neighbors like the Nimbys, from the great benefits such up-zoning entails, there is no reason for them to be in favor.

Zoning creates an 'Economy of Externality' by reducing suboptimal spatial adjacencies that experience suggests generate negative effects. Recall that externalities require not just a polluter but also a pollutee. If no one were in the woods to hear, the drunk partiers did not create a noise externality. If Nick and Nora Nimby had not earlier moved next to a kosher pig farm, they would not be bothered by its smell. If the Nimbys did not also live next to a gravel pit, its flying shards will matter not.

MEET THE YIMBYS. Yves and Yetta Yimby¹⁴ argue no one owns the right to uncongested roads and uncrowded facilities, and agree with the developers, market urbanists, and planners who support them in their quest for the highest and best use. The Yimbys note that

¹² NIMBY is a pejorative acronym for 'Not in my backyard', reflecting the view of neighbors who are opposing a new development or public facility nearby, whether or not they oppose it as a general principle. We believe there may be good reasons to oppose particular developments or the locations of particular facilities, but remain skeptical about whether the opposition in particular cases comes from such reasoning or simpler selfishness.

¹³ Lower property value may be real or perceived.

¹⁴ YIMBY is an acronym for 'Yes, in my backyard' and formed in opposition to NIMBYS blocking development.

denser cities are better for the global environment and the economy than the alternative (suburban development or no development). However, the Nimbys say the Yimbys think they can just offload these costs to local neighborhoods and their streets and it is okay. But what they do is take time and quality of life from other people by increasing congestion and crowding. Recall that the Nimbys think (presumably by custom, status quo, or some other logic) that they have the right to prevent these externalities, and they do so with restrictive zoning. Zoning regulates negative externalities that are not currently governed by Pigou or Coase.¹⁵

¹⁵ (Coase 1960; Pigou 1920).

...

Neither side is inherently right, the problem at its core is undefined property rights and un-tolled roads. It is just two sides of selfishness: greedy developers seeking profit vs. greedy NIMBYs protecting their expected property values.¹⁶ It is just two sides of selflessness: selfless developers promoting the urban economy, increasing accessibility, and reducing inequality for society at large, or selfless NIMBYs trying to ensure that quality of life is maintained for the neighborhood and the future.

¹⁶ It is possible that NIMBYs may think they are protecting their property values but are actually harming their overall value. In areas with high demand, if developers are allowed to build more units they can afford to pay more for land as there are more units over which they can spread the costs.

ZONING CREATES TACIT RIGHTS THAT PEOPLE WILL EXPECT COMPENSATION FOR, WHEN CHANGED. This is not to say any particular zoning regulation is appropriate, efficient, or equitable. It is to say there is a 'fact on the ground' that has created a set of tacit rights that ought not be blithely unseated without expecting to provide compensation from the putative gains by rezoning or dezoning to those for whom this implicit contract between the public and private owners has been made. There are many options for providing these economic side payments. There has been some preliminary discussion about side payment in research on congestion pricing, but this needs to go much farther. This can be applied for all types of transport investments and land uses at various scales. There will always be arguments about price, but if the neighbors ask too much, *status quo ante* prevails (the developer won't develop). If the land use revolutionaries offer too little, the *status quo ante* still prevails (the local politics will not permit approval). If there were truly gains from trade, there should be a core to this transaction. The logic of the ultimatum game might be informative.¹⁷

¹⁷ (Thaler 1988).

Yves and Yetta Yimby need to enable Nick and Nora Nimby to be winners too if they are to support changing zoning and other land use regulations.

...

Systematically, there are four cases when a developer is considering building somewhere:

1. *The zoning is not binding, without externalities.* In this case the zoning exceeds market demand, but the negative externalities are small. This case is not a problem for developers or the community, and the development proceeds without hitch.
2. *The zoning is not binding, with externalities.* In this case the zoning exceeds market demand, but there are negative externalities to development which the neighbors want to avoid. This case is a problem for the community, which must now pay the developer not to develop, or must pay to mitigate the externalities. We see this when communities purchase development rights (for instance, agricultural reserve areas). Here the Coasian right to develop resides with the developer.¹⁸

¹⁸ (Coase 1960).

...

One can see difficulties with these scenarios. Developers can threaten to develop, and get paid not to develop, even though they were not serious. Bluffing is very easy. Hence the desire for communities to control the development rights through restrictive zoning. Residents must act through government because of the asymmetry and coordination costs, one-thousand neighbors all harmed slightly do not have the ability or incentive individually to give a side payment to a developer not to develop at all (or as much), because some residents will want to free-ride on the side payments of others. Only through the government or a government-like organization can this be achieved.

...

3. *The zoning is binding, with side-payment.* The developer through either request or lobbying (perhaps at some monetary expense) gets an area rezoned. The lobbying allows political decision-makers to collect rents from restrictive zoning, or neighbors to achieve side-payments. These side-payments compensate the community for the negative externalities that will be received upon a change in the status quo. The political rents are a problem for the political system and how we finance campaigns or administer bribery laws. This case costs the developers money, but in the end if they choose to build, it still must generate above 'normal profits,' otherwise it would be

better for the developer to keep their money in a bank account. This results in a transfer of money, but is at least neutral and probably win-win.

4. *The zoning remains binding, without (sufficient) side-payments.* The land is not rezoned because the developer's payments were, or would be, insufficient to persuade the opponents or decision-makers. This case might result in some social loss (especially if there are, in fact, economies of agglomeration), but what is happening is that the loss perceived by the opponents outweighs the benefits perceived by the developer. There may be of course miscalculations about the opponents willingness to pay or willingness to accept, but in the end the potential gains did not outweigh the potential losses, and the project may not have been as good as claimed.

If there is value, where are the side payments from otherwise rejected developers? Our perhaps cynical view, "No side payments, no evidence of super-normal social profits, no evidence of huge value being lost." While the developer may be losing potential profits, society is not losing much, as those who are negatively affected are not being given compensation to offset the negative effects they would receive were the project to go forward. We realize there are transactions costs limiting the ease of implementing side payments, but surely some institution could arise to facilitate this.

THE SCOPE OF ZONING CONFLICT IS NARROW. These arguments are generally fought on the margins though. Most of the United States (territory-wise) is in the first case from the previous list. Zoning is well in excess of demand. Zoning bites in some fast growing and wealthy areas, notably New York City, Washington, DC and its suburbs, and the San Francisco Bay Area. Washington, DC and New York are both very special edge cases, being political and financial capitals respectively, both of which at least historically generated important economies of agglomeration. The San Francisco Bay Area is more complicated. Obviously there is some economy of agglomeration in the technology sector, and there economies of amenity in the City of San Francisco for many higher income people.

Density naturally produces more regulation because density naturally produces more externalities: both more pollution and more pollutees. Whether the zoning reflects the wishes of developers or neighbors depends on context, and as population density increases, we would expect the neighbors to become relatively more powerful, if only because the negative externalities

of development become apparent to more and more people, as well as increasing in scope. Similarly as wealth increases, neighbors gain political strength. And since high-density areas are naturally more expensive (due to greater demand, otherwise they would not be high-density), and high-density areas are also typically formed by physical constraint, meaning less supply, they are likely to be more regulated.

Yet, even relatively dense and expensive metro areas have inexpensive housing in places, it just tends to be either lower quality, or in less desirable neighborhoods.

13.2 *Height limits*

HEIGHT LIMITS LIMIT NEGATIVE EXTERNALITIES AND CREATE POSITIVE EXTERNALITIES. Height limits are a particular form of zoning that restrict the maximum height of structures in some cities. It is often initially promoted to protect viewsheds, so for instance, views of the Capitol building in Washington, DC are not obscured by buildings too tall. It has the same effects as zoning of limiting development for all the reasons noted above.

Urbanists oppose building height limits. In contrast, we argue that height limits are not an especially important problem, and are a solution to some other problems

The density of Washington, DC, notorious for its 10 story height limit¹⁹ feels right for a city, much like Tokyo, London, and Paris (all notable for a lack of overly tall buildings). In DC, the buildings are not too tall and canyon like, and there are few vacant lots in the core. But there remain plenty of low density sites elsewhere in the city, as shown in Figure 13.1.

What do height limits do? They restrict buildings over X stories. Thus more buildings less than or equal to X stories are built over a greater footprint if demand is fixed. In other words height limits reallocate development. The consequence is that a larger area is urbanized at a high density (at or near X stories), rather than a smaller area at a very high density and a larger area at a lower density. In Washington, there is a much larger urban sphere than, say, height-limit-less Minneapolis, where high-rises in downtown are surrounded by many low-rise and surface parking lots.

Instead of having 10 blocks of 50 story buildings, Washington has 50 blocks of 10 story buildings. Is this a really worrisome outcome?

This additional urbanized space is a positive externality in a number of ways. Better urban form (more sidewalks are walkable),

¹⁹ Technically the limit is 110 ft (33 m) and is tied to street width.

less congestion (traffic is spread out over more space), less pollution intake ('the solution to pollution is dilution,' the bad stuff is spread over more area), less crime (more eyes near street level), more serendipitous random meetings on the street (which supposedly create greater productivity) and so on.

At one limit, we could have a height limit of 1 story, and spread everything out, at the other, we could have no limit, and buildings would be as concentrated as the market and structural engineering could support. Clearly the first is extreme, but so is the second, so long as we have unpriced externalities. We live in an imperfect (second-best)²⁰ world with many unpriced externalities (congestion and pollution among them), which have no clear property rights. Regulating heights is one of many second-best solutions to this problem.

²⁰ (Lipsey and Lancaster 1956).

Do the height limits imply more suburban development? Sure, someone who really, really wants a high rise for some reason will have to locate in the suburbs.

But we can't think of a good reason except ego and marketing for needing a high rise in a place like Washington, while we see many inefficiencies associated with tall buildings: greater distance to the ground floor and thus to people in other buildings (in the absence of skyways on the 50th floor), limited interactions on the upper stories, so much floor space devoted to elevators, higher construction costs, etc.

By and large, suburban development in the DC suburbs is not for lack of space in Washington, but rather due to a preference for the suburbs. Cities without height limits get their share of suburban development for all the usual reasons (lower land costs, easier access for workers, etc.) when day-to-day inter-firm accessibility is not particularly valuable in their sector, and intra-firm accessibility still matters.

One of the critical problems here, as with many economic phenomena, is the difference between marginal and average effects. For instance, clearly transport matters: if there were no transport there would be no economic activity. However, that does not mean that a marginal increase in transport supply will have a significant, or even positive, effect on economic activity, that depends on context. When the network is mature, as is true in many large US cities, the marginal returns to new investment now are much lower than the historical average returns.

Similarly, the marginal returns to density might be much smaller than average returns. Cities exist for a reason. That reason is economies of agglomeration in various forms. That said, where

cities are continuing to grow, those economies must be valuable. Where suburbs are growing, the daily face-to-face inter-firm interactions emerging from the classical 19th and early 20th century transit-based downtown has declined relative to the need to be within auto-commuting distance of places that are to be dealt with on a short-term basis. When new cities grow, new patterns of economic activity are forming, and these may be more valuable than incremental changes to mature cities.

There are several points wrapped up in this:

- Empirical questions about intra-urban vs. inter-urban migration – Do height limits move development to the suburbs or another metropolitan area altogether?
- The rights of the property owner vs. the rights of the community.
- Economic productivity and positive externalities vs. pollution, congestion, and other negative externalities.
- Empirical questions about the scarcity of land.
- Empirical questions about what constitutes good urban form.
- Empirical questions about the need to be downtown or simply in the metro area – plenty of suburbs even in DC would be happy to accommodate growth.

All of which is to say cities and their economies are dynamic, and the first order factor is the underlying market economics, while regulations (which are themselves the product of political market preferences) are second order effects.

13.3 *Should the Bay Area have 11 million residents?*

California, and the booming San Francisco Bay Area in particular, has caught the ire of many who blame restrictive zoning for causing economic harm to the country. In 2012, Tim Lee wrote in *Forbes*: “Why The Bay Area Should Have 11 Million Residents Today”:²¹

²¹ (Lee 2012).

Today, the Bay Area has about 7 million residents.²² In a free housing market, the population of the San Francisco Bay Area would have been growing rapidly over the last two decades. For example, between 1900 and 1920, the growth of the auto industry helped the population of the Detroit metro area nearly triple, from 540,000 people to 1.4 million people. If the San Francisco Bay Area had grown that fast since 1990, it would have about 16 million people today.

²² Estimated at 7.76 million in 2017.

²³ David Levinson lived there from 1994-1999, and saw first hand the benefits and costs of rent control.

²⁴ §7.

We don't doubt there are housing restrictions in Bay Area municipalities.²³ There are many municipalities. Some would welcome development. Others just demand more side payments, compensation for the [negative externalities](#)²⁴ more residents bring.

The so-called economies of agglomeration are just not large enough to justify development in less desirable areas, or side payments to compensate the existing residents of developed areas, or they would be made. Nor are they enough to overcome social problems constraining gentrification.

To get to Lee's 11 million, four million people have to come from somewhere (he's not arguing for millions of new babies by existing residents). Maybe they come from Phoenix or Dallas or Houston or Atlanta, or, of course, everywhere. But then those places have the infrastructure, land, and housing stock, where if the demand were lower would just see lower land prices, not less people (mostly).

Maybe some development would not have been built in those other metros. But that development (i.e. roll back the last 10 years of US development for two million housing units, reallocate that to the Bay Area, as is implied in the article) and most of that would be single family houses that would be unbuilt. Preferences for two million single family homes cannot physically be satisfied in the Bay Area, so residents would thus face a worse housing situation than preferred.

We have a friend from Minneapolis we nicknamed 'Pre-Millennium Man,' since in the early 2000s he wanted to live the 1990s hipster dream of San Francisco. He moved to the Bay Area and found work in software development. Nothing stopped him. He undoubtedly outbid someone who did not care to live there quite as much. The people who are outbid contribute much less to the economies of agglomeration than the average person who is there (their wages reflect willingness to pay for housing, and are determined by their productivity). Adding two million marginal workers to the pool won't increase the total productivity as much as the average person today, and will ultimately reduce average productivity. It will also worsen the aggregate productivity elsewhere.²⁵ There are diminishing economies of agglomeration, and increasing negative externalities with larger populations.

The entire rationale for housing regulations is to reduce negative externalities, both perceived and real. If we lived in a world where those externalities were otherwise internalized, communities would be much more willing to allow more development, as the negative spillovers would not exist. We do not yet live in that world.

²⁵ At Georgia Tech, there was a common joke about the student who failed out and had to transfer to rival University of Georgia, thereby improving the average IQ of both schools.

The Bay Area (thinks it) is the most important place in the world, delivering us the future. Real productivity is created there, but so is crap and redundant software.

Veteran journalist and Recode founder Kara Swisher once quipped that San Francisco was becoming an assisted-living community for millennials. She wasn't exaggerating.

The on-demand economy could easily be rebranded as the "mother-on-demand" economy. Cleaning, laundry, taking out the trash: Its goal is basically eliminating all the chores you once did as a kid.²⁶

²⁶ (Hartley 2017).

A much better strategy would be to stop wasting so much effort on duplication, drivel, and so on, and incentivize those competent software developers to make things that are worthwhile. If people can no longer find good investments, or can no longer distinguish between good investments and bad ones, perhaps the economies of agglomeration have been exhausted.

Alternately, the economies of agglomeration might not lead to societal benefits. Consider the finance industry in New York, which is another city with high housing costs blamed on zoning regulations. The industry has increased productivity and sophistication, but it is not clear that these innovations are always desirable. For instance, financial derivatives are one of these innovations. Yet Warren Buffett has gone so far as to call financial derivatives "weapons of mass destruction" in a 2002 report to Berkshire Hathaway shareholders.²⁷

²⁷ (Buffett 2002).

Again, the limits of agglomeration economies can be reached.

14

Fielding Dreams: Induced Demand, Development, and Supply

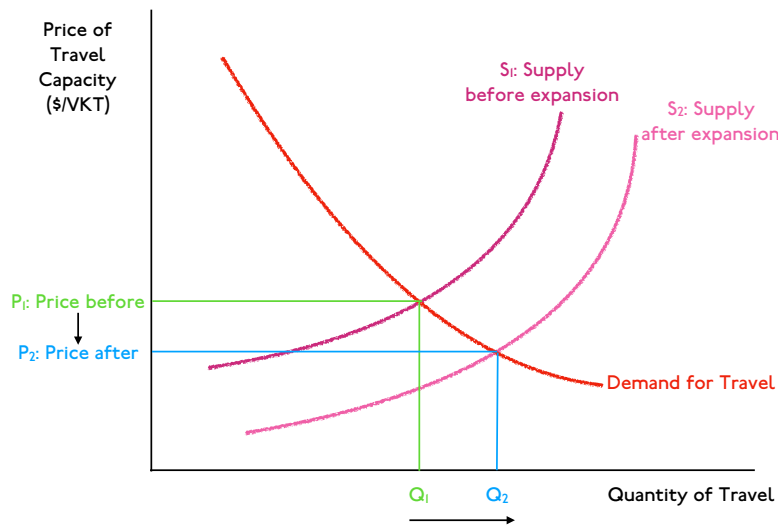


Figure 14.1: Induced Demand.

In the Kevin Costner 1989 film *Field of Dreams*, a ghost whispers “If you build it, he will come.” ‘It’ refers to a baseball field; ‘he’ is the ghost of Shoeless Joe Jackson, a baseball player idolized by protagonist, ‘you’, Ray Consella.

This has been adopted by planners to describe the idea of induced demand: “If you build it, they will come,” which, interpreted in transport, means that if a place (‘you’) builds a new facility (‘it’) (road, tracks, etc.) demand in the form of travelers (‘they’) will respond and use it – making trips that previously would have been unmade. This has multiple causes. In our use, *induced demand* (and its converse *reduced demand*) results from people changing route, schedule, mode, destination, or location of

home or work within the existing built environment, or even choose whether to make a trip at all, because of a change in access. The related *induced development* occurs when people and firms develop new real estate to advantage themselves of access, and so is a longer run phenomenon. *Induced supply* is the change in the network that occurs due to changes in demand patterns, and reflects the response of infrastructure and service providers to changed conditions.¹

¹ (Levinson and Karamalaputi 2003a;b).

Induced demand (and development) is not surprising to anyone who has thought about this, and the idea of induced demand has long been well understood, even if the magnitude of induced demand associated with any given project is difficult to estimate, and the models are not used appropriately, and internal consistency between model inputs and outputs is still not standard practice.² A related notion is Say's Law, from 1803: Supply creates its own demand, or more pedantically as per Wikipedia "that aggregate production necessarily creates an equal quantity of aggregate demand."³

² David Levinson did his MS Thesis on this more than 25 years ago, and it wasn't a new idea then. See (Levinson and Kumar 1994a). Also see (Levinson and Kumar 1994b) for implicit recognition of the idea.

³ (Wikipedia contributors 2018i).

This has been illustrated using economic supply and demand curves, such as in Figure 14.1. To an economist this *induced* or *latent* demand was always there, just unrealized until the cost of travel was lowered by the new capacity. The road (or train) fills up, congestion returns, or at least the expected congestion reduction benefits do not last long, as travelers adapt to the new environment. The consumers' surplus increases, as people can now do things they want to do at lower cost.

In the planner's telling, only the hapless traffic engineer (or traffic modeler who is as often a planner as engineer), who made the partial equilibrium assumption that demand does not respond to supply, is surprised by this growth. In the anti-automobile advocates version, induced demand is not merely a thing, it is a bad thing.

We want to establish several points in this chapter. First, we define induced demand and development. Second, we claim that induced demand is good of itself, but can impose negative effects. Third, how can we identify whether it exists. Fourth, we have known about this a while, but tend to forget what we know.

14.1 Defining induced demand

Demand is a function – not an amount.⁴ We find the amount (of travel) when we intersect the supply function with the demand function as in Figure 14.1. Transport improvements, whether the construction of a new runway at an airport or the signal coordination along an urban arterial, change the supply function,

⁴ We are indebted to reader Jay Wetmore for this argument in this and the next section.

(from S_1 to S_2) and therefore increasing the quantity of travel consumed (from Q_1 to Q_2), and lowering the price (from P_1 to P_2).

While we might think we are ‘consuming travel’, we might alternatively say we are ‘realizing the potential of access’. Access can be thought of as a *merit good*.⁵ Merit goods are what most people think of when they talk about **public goods**,⁶ without the messiness of concerning ourselves with rivalry and excludability. Merit goods are normally associated with positive **externalities**;⁷ and as such are considered to be something that individuals or societies should have on the basis of need; and something that will be under-supplied by the market, making public provision desirable.

⁵ (Musgrave 1959).

⁶ §A.

⁷ §7.

We lay out four specific hypotheses (and four null alternatives) that can be generated, varying three dimensions: construction (supply), demand response, and sequence:

- If you build it, will they come? [Induced Demand Question]
 - $H1$: Build it and [then] they will come. [Because demand responds to supply, or because it was coming regardless] [Compare $H2$]
 - $H1_{null}$: Build it and [then] they won’t come [Because demand is independent of supply]. [See $H4$]
- If they come, will you build it? [Induced Supply Question]
 - $H2$: They come and [then] you will build it. [Because supply responds to demand, or because you were building it regardless] [Compare $H1$]
 - $H2_{null}$: They come and [then] you didn’t build it. [Because supply is independent of demand] [See $H3$]
- If you don’t build it, will they come? [Exogenous Demand Question]
 - $H3$: Don’t build it and [then] they will come [anyway]. [Because demand is independent of supply] [See $H2_{null}$]
 - $H3_{null}$: Don’t build it and [then] they won’t come [Either because demand is independent of supply, or because you didn’t build it]. [See $H4_{null}$]
- If they don’t come, will you build it? [Exogenous Supply Question]
 - $H4$: They don’t come and [then] you build it. [Because supply is independent of demand] [See $H1_{null}$]
 - $H4_{null}$: They don’t come and [then] you didn’t build it. [Either because supply is independent of demand or because they didn’t come.] [See $H3_{null}$]

Each of the hypotheses in the box tells us something a bit different. There is both the dependence of the supply-demand question (are they dependent or independent), and there is the sequencing (which comes first, transport or land use).

Of course these are binaries, and we could consider how many of ‘them’ need to come for us to say ‘they came.’ So you built a stadium

to seat 10,000 and 5,000 came, is that evidence of induced demand? In short, yes, but not as much as you planned for.

Karl Popper developed the idea of falsifiability, which says: “[I]t must be possible for an empirical scientific system to be refuted by experience.”⁸

⁸ (Popper 2005).

Sequencing matters here, and it’s hard to prove a negative. A single sequence of events cannot provide proof for induced demand. Maybe Shoeless Joe and the rest of the ballplayers were going to show up in Kinsella’s Field anyway, and the field just accommodated them. Just because they never showed up before he built the stadium is not the evidence we require. Instead, we need to compare multiple cases to justify our case, and build the evidence for it.

A sequence of events can however disprove induced demand (or supply), as the list above illustrates, there are several cases where construction does not result in demand (we can conclusively disallow induced demand in that case) or where demand does not create supply (we can conclusively refute induced supply).

There are some other issues, such as what if they come and you didn’t build it (or, reversing the sequence, you didn’t build it and they come)? What is the correct sequence in the absence of an event, the absence being not building something? It is impossible to state when the event of not building something actually happened as not building something is always happening. The related question is when did the absence of demand occur?

⁹ §7.

¹⁰ §13.

In either case, [negative externalities](#)⁹ ensue, which is the [NIMBY](#)¹⁰ fear of growth without supporting infrastructure. NIMBYs may not want the growth with the supporting infrastructure either, but their main complaint, on face value, is growth without it, which realistically may negatively affect their personal quality of life and property value. Whether or not you believe they should prevail, you at least understand their point-of-view.

Policy responses to ensure consistency between supply and demand include concurrency or adequate public facilities ordinances (APFOs). These are rightly treated skeptically by the public.¹¹

¹¹ David Levinson once worked on implementing APFOs and growth management / concurrency regulation in Montgomery County, Maryland. He recounts the analysis in *The Limits to Growth Management* (Levinson 1997).

14.2 Induced demand can be a good thing

From the individual’s point of view, access provides opportunities to more jobs, more entertainment and social options, and more alternatives for consumption of goods and services. From a business’s point of view, access provides a larger pool of labor and

more raw materials. From a retailer's point of view, access provides a larger pool of consumers. From a municipal government's point of view, access allows more efficient provision of police protection, fire protection and ambulance service by reducing the number of facilities necessary to maintain acceptable response times.

Transport improvements that provide greater access per unit of time lower transaction costs. Lower transaction cost lead to great efficiency in the economy and a higher standard of living.

In telecommunications networks we have witnessed several orders of magnitude improvement in capacity during our lifetimes, yet we have always filled the new capacity. We stream video now when we once sent text files. Yet few wring their hands about the induced demand in our telecommunications network.

The key difference is that all of this additional travel has visible side effects that consuming telecommunications does not.¹² Your peak hour trip [congests](#)¹³ our commutes. Your tailpipe [emissions](#)¹⁴ makes us sick. Your travel increases our [crash risk](#).¹⁵ The list goes on. If society underprices these externalities, induced demand can result in economic bads (the opposite of economic goods). However, reducing travel itself has costs (which reduce benefits), so it is not obvious which is worse *a priori*. We discuss solutions like [pricing](#) elsewhere.¹⁶

¹² Which is not to say that watching home-made internet videos is good for your brain, nor that texting while driving is good for your (or anyone else's) health.

¹³ [§5](#).

¹⁴ [§8](#).

¹⁵ [§7.7](#).

¹⁶ [§6](#).

14.3 *Forgetting faster than we learn*

There are many new players in the world of transport policy. On net, the influx of new actors into the policy, advocacy, and planning realms is likely a benefit, but does offer some concerns. One thing that we see again and again is that new entrants and existing players in the world of urban transport policy too often don't know or have forgotten lessons learned in the past. On one level this is just a nuisance, and it is good that old knowledge is rediscovered. On another more troubling level this is like health professionals having to rediscover penicillin every other generation.

In a *Vox* piece¹⁷ the concept of induced demand was discussed with reference to empirical work by the economists Gilles Duranton and Matthew Turner.¹⁸ As noted above, induced demand is a well-known concept that goes back formally at least to Anthony Downs' 'Iron Law of Congestion',¹⁹ and was discussed informally by Lewis Mumford (in 1955),²⁰ who was referring to Mitchell and Rapkin's *Urban Traffic: A Function of Land Use* (1954).²¹ Evidence goes back much farther, including implicitly the Adam Smith references discussed in [Chapter 1](#).²²

¹⁷ (Stromberg 2015).

¹⁸ See (Duranton and Turner 2011). *Wired* (Mann 2014) also wrote about this particular work. We don't particularly blame economists for taking credit for long established ideas, it's a professional tic, we blame journalists for their credulity.

¹⁹ (Downs 1992).

²⁰ (Mumford 1955).

²¹ (Mitchell and Rapkin 1954).

²² [§1](#).

Yet the *Vox* piece suggests induced demand is new knowledge. Reading beyond urban economics research reveals that scholars in transport economics and urban planning had already extensively explored induced demand. In a 1995 *ACCESS* article Mark Hansen describes the problem.²³ Phil Goodwin (citing observations from 1938),²⁴ Robert Cervero,²⁵ Robert Noland,²⁶ Robert Cervero and Mark Hansen²⁷ and David Levinson²⁸ are some of the scholars who have published in leading journals, presented at conferences and included induced demand in their teaching. Here is what Robert Cervero wrote:

No issue has paralyzed highway programmes and side-tracked our ability to rationalize new road development as concerns over 'induced travel demand.' Time and again, experiences show that building new roads or widening existing ones, especially in fast growing areas, provides only ephemeral relief – in short time, they are once again filled to capacity. A study using 18 years of data from 14 California metropolitan areas found every 10% increase in highway lane-miles was associated with a 9% increase in vehicle-miles-traveled four years after road expansion, controlling for other factors. Similar findings have been recorded in the United Kingdom. In the United States, regional transport plans, such as in the San Francisco Bay Area, have been legally contested by environmental interest groups on the very grounds that they failed to account for the induced travel demand effects of road investments and expansions.²⁹

Cervero's summary article³⁰ is worth reading for nuance about what induced demand really means for transport planning and policy. He notes that while induced demand claims have stopped highway expansions in the past, induced demand claims gloss over more important concerns about the use and costs of travel.

It is also worth noting that even though induced demand is usually discussed in the context of expanded road capacity, induced demand actually applies for any particular transport technology. Transit expansion along a corridor has the same effect on induced demand as road widening. On his blog, transport scholar Kevin Krizek explained how congestion is a poor argument for expanded cycling facilities also because of induced demand.³¹ We actually know a lot about how transport capacity affects the price of travel, which affects demand for travel across time and space.

This is just one example, but many newly interested and well-intentioned people are wading into transport policy based on limited reading and personal anecdotes, and if we follow their lead we will have to relearn all the things that we already know. Forgetting knowledge is not a new phenomenon and not limited to

²³ (Hansen 1995; Hansen and Huang 1997).

²⁴ (Goodwin 1996).

²⁵ (Cervero 2003b).

²⁶ (Noland 2001).

²⁷ (Cervero and Hansen 2002).

²⁸ (Parthasarathi et al. 2003).

²⁹ (Cervero 2001).

³⁰ (Cervero 2003a).

³¹ (Krizek 2013).

any particular set of experts, but it is problematic and deserves more discussion about how to fix it. In a lead editorial in the May 2014 *Planning Magazine*³² the American Planning Association's CEO, Paul Farmer, begins as follows:

³² (Farmer 2014).

During a chat about planning in the US and Canada, several planning colleagues addressed the topic of value capture. "We've coined the phrase 'windfalls,'" one Canadian colleague proudly remarked in describing the unearthed benefits that a property owner might realize from investment made by others.³³ The late Don Hagman might have been pleased, amused, or irritated by this appropriation of the concept he popularized, if not invented, in his extensive writings half a century ago.

³³ The book referenced is *Windfalls for Wipeouts: Land Value Capture and Compensation*. (Hagman and Misczynski 1978).

Concern about keeping knowledge alive isn't just sour grapes about all the stuff we learned in grad school that people ignore. It's not clear how we can steadily move policy forward (in a better way, however 'better' is defined) if we can't keep the lessons of the past in mind. This is not a question only for transport policy, either. In *The History Manifesto*³⁴ Jo Guldi and David Armitage argue that historical study should play a larger role in economic and policy debates.

³⁴ (Guldi and Armitage 2014).

As transport policy attracts more specialists from fields outside of transport – economics, computer science, software engineers, data miners, etc. – the challenge of sharing existing knowledge rather than rediscovering knowledge is really important. We don't need to have lots of policies that won't work just to relearn that such policies don't work.

Trains, Planes, and Automobiles

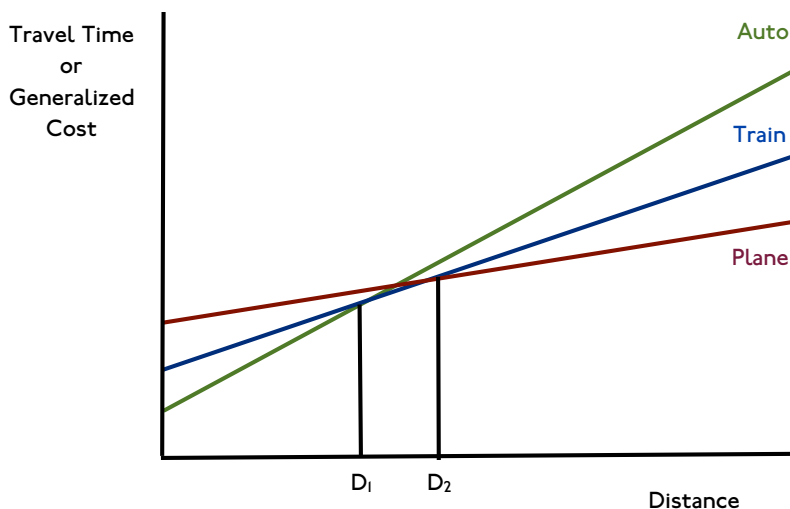


Figure 15.1: Planes, Trains, and Automobiles.

It might seem strange to include a chapter on intercity transport in a part of the book about cities. But when you think about it, intercity transport is mostly about extending the scope of the city, bringing more territory into the daily urban market. Commuter trains emerged from intercity trains. The Interstate Highway System mostly serves daily urban users. We expect the same will be true of new surface transport modes that might get deployed, such as high-speed trains.

Figure 15.1, which is standard in transport economics or geography illustrates the market trade-off for intercity transport.¹ The question is whether there is a range between D_1 and D_2 ; that is, does rail actually dominate both autos and planes over any distance. In terms of travel time it probably does (especially

¹ Similar graphs apply to freight, just relabel it to Trucks, Trains, and Ships.

² The industry is conflicted between hyphenating *high-speed* or not, *high speed*. We hyphenate except for proper names which are not.



Figure 15.2: US High-Speed Rail System Proposal by Alfred Twu.

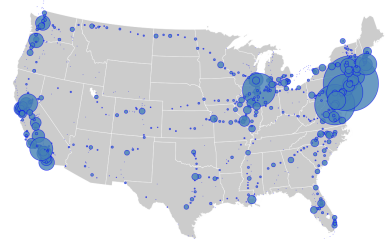


Figure 15.3: Amtrak Ridership by Mike Hicks.

³ Recent proposals include Los Angeles to Las Vegas, Houston to Dallas, and Miami to Orlando, the last of which has seen new privately-operated Brightline conventional rail service.

⁴ High-speed rail construction generates pollution and greenhouse gases that takes years of operation (and substitution for other modes) to recover. (Chester and Horvath 2010; Levinson et al. 1999).

considering additional time for security at airports), and looking only at operating cost, it might. In terms of overall cost, including the fixed cost of construction of a new high-speed rail (HSR) line,² it probably does not under current cost structures since capital costs are so high. The size of this range, if it exists, is, however, empirical, and subject to change with costs and technologies.

15.1 Mapping high-speed rail

Maps are powerful ideas. A map once drawn can be viewed as a contract, a promise to build something. We live with the ghosts of maps drawn long ago. Unbuilt highways queue-up to get built, even when their rationale has disappeared. But lines remain unbuilt for a reason, people perceive the benefit do not outweigh the cost. Of course, conditions can change, a line which once failed a benefit-cost test may now pass it, or vice versa.

High-speed rail advocates have long assembled maps of proposed routes. These present different visions of the future, and they can't all come to pass. But does that mean none of them should?

A private firm would build high-speed rail if the expected profits exceeded the expected costs. Clearly that is not generally the case in the United States, otherwise we would see more evidence of this. There are certainly proposals,³ some farther along than others.

The public sector remains uninterested in *profit*, but instead should favor the more ambiguous *general welfare*. High-speed rail makes sense when the full economic benefits outweigh the full economic costs. The potential benefits include time savings for travelers, increased reliability, improved quality of service, reduced congestion on roadways and at airports, reduced pollution from automobiles and airplanes, and more economic activity as a result of the improved accessibility. The potential costs are those of constructing the system, operating it, the pollution costs associated with construction and operations, and so on. The evidence is that the environmental capital costs of the new system do not outweigh potential reductions in pollution.⁴

The first map (Figure 15.2) nicely draws with bright colors a possible United States High-Speed Rail System. The second map (Figure 15.3), shows actual Amtrak ridership. Actual ridership is highest in the Northeast corridor, where the Acela service, along with other conventional passenger rail runs today. The other big Amtrak markets are between San Diego and Los Angeles, between Sacramento and the San Francisco Bay area, between Seattle and

Portland, and between Chicago and a variety of midwestern cities, in particular St. Louis.

Corridors that get traffic now with relatively slow service are more likely to get higher levels of demand when upgraded (made faster and more frequent) than corridors that get almost no ridership now. This argues for incremental upgrades where the benefits outweigh the costs, and focusing on specific proven markets rather than trying to connect random large cities.

We should be looking for routes where train is more cost-effective than either driving or taking an airplane. This distance is certainly less than 1000 km^5 for most of the US, under current costs of travel. Once we have proven we can connect large places closer than 160 km^6 we should connect large places less than 320 km^7 and then expand outward. We should not start with a grand vision which will simply collapse of its own weight. We should also be looking for routes with large trip generators at either end.

Examining the first map shows a lot of non-sensical routes. We can't rate them in order of non-sensicalness, some are just too problematic. This is not to say there are not segments which could productively be (and are) served by rail. The Northeast corridor is one. Chicago to Milwaukee is one. Los Angeles to San Diego is one. There are a few others. The key point is they are local serving, and should be locally supported. There is no need for US federal involvement. If the projects were worthwhile, the states and cities and private railroads should fund them. Almost all the benefits are local, the costs should be borne by those who benefit.

These segments can grow into systems that should be (1) separately organized, managed, governed, and operated to improve local responsiveness and reliability, and (2) allowed to evolve organically based on incremental changes and extensions. We do not ask San Francisco's BART to interline with Washington DC's Metro,⁸ nor should we expect a useful local service from Chicago to Champaign-Urbana to interline with a potentially useful route from Richmond to Washington, DC. By doing so you create dependencies: a blizzard in the Northeast holds up train service in Illinois, without any advantages.

High-speed rail is a difficult proposition to begin with in the United States. In the more than 50 years after it was opened in Japan, it has yet to come to pass in the US.⁹ There are reasons for this, beyond simple political obstinacy. The markets are different, the conditions are different. When HSR was opened in Japan, its airlines were highly regulated. Further, Japan has a much higher overall population density. The US has been unimpressed with its



Figure 15.4: Network by California High-Speed Rail Authority.

⁵ 600 mi.

⁶ 100 mi.

⁷ 200 mi.

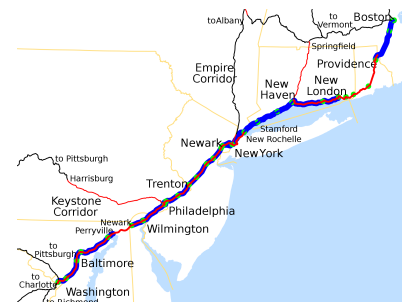


Figure 15.5: New York Hub Network.

⁸ We might hope for technical interoperability to have joint purchases and achieve economies of scale. Unfortunately, BART and DC Metro in fact use separate gauges.

⁹ We are aware of Amtrak's Acela, which is not true HSR. We are also aware of California's HSR project, which, while under construction, is still far from opening, if it does at all. There is not currently funding lined up to complete the project.

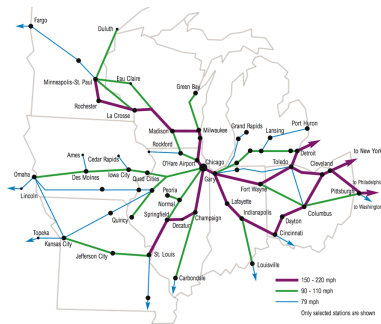


Figure 15.6: Chicago Hub Network by Midwest High Speed Rail Association.

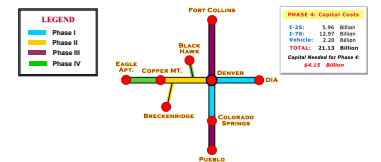


Figure 15.7: Denver Hub Network by Rocky Mountain Rail Authority.

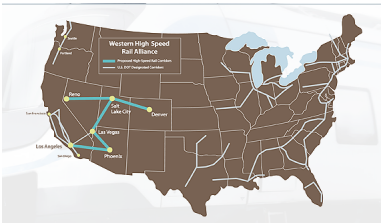


Figure 15.8: Salt Lake City Hub Network by Western High Speed Rail Alliance.

¹⁰ 220 mph.

passenger rail service for many decades, since well before Amtrak was formed to pick up the pieces of private passenger rail service, and has lost its rail-building and train-building skill-base.

When we study successful technologies and networks such as the Internet or the London Underground, we see they grow from a seed, and expand outward – not from the top down. This is natural, it is risk-averse, it allows learning to occur before over-building. Not all technologies or networks will succeed, it is best to learn that early, rather than after building a giant White Elephant.

15.2 A national high-speed rail network

Eric Peterson, President of the American High Speed Rail Alliance, at a conference dinner estimated that a complete national truly High Speed Rail (HSR) system for the United States (on the order of 350 km/h¹⁰ peak speed), not simply an improved Amtrak system, would cost about \$2 trillion, give or take. This sounds about right. This is about the cost of 2000 professional football stadiums. A HSR network would be a better investment than 2000 Stadiums. This would also be the cost of 2000 LRT systems equivalent to the Twin Cities’ Central Corridor (Green Line) project, which would serve more people on a daily basis, and probably more passenger miles as well.

Is this a good thing for the United States or for any given state? The answer differs. From a local perspective, someone else spending money *here* is a good thing, and spending our money *somewhere else* is not. A local benefit/cost analysis (which excluded non-local benefits and non-local costs) gives a different answer than a national benefit/cost analysis. If someone picks up half the bill (which is typical for transit projects) or 90%, which was the case with the Interstate Highway System, the local incentive for match is much greater than if the locality must pick up 100% of the cost.

The network Peterson promoted was essentially a hub-and-spoke system. Minnesota is at the end of the Chicago-based “Chicago Hub Network” (Figure 15.6). Clearly this is more advantageous for Chicago than Minneapolis, Chicagoans can (going counter-clockwise) get to Minneapolis, Madison, Milwaukee, St. Louis, Kansas City, Indianapolis, Louisville, Cincinnati, Columbus, Cleveland, Toledo, and Detroit, among others. Minneapolitans can go to Madison, Milwaukee, and Chicago before the travel time becomes unreasonable. The access from Chicago is much greater, and thus their benefit is much greater. Chicago has a much greater interest in this than Minnesota.

If Wisconsin were to pay for the line from Milwaukee to LaCrosse, the extension to Saint Paul would be relatively short, and the political economics (local Benefit/Cost Ratio) would differ from the case where Minnesota paid for half the line crossing Wisconsin.

The logic also varies based on whether the line can be used for commuter traffic in addition to HSR traffic. The history of transport is rife with long-distance transport infrastructure being adopted for short-distance travel. The Interstate is only the most recent example (commuter railroads are another example).

The cost is not small. The nature of HSR is that fixed cost is much greater than other modes, and the variable cost (per trip) may be lower. If the demand were great enough, this trade-off would be worthwhile, but when demand is small, the resulting White Elephant can never repay the initial fixed cost. Thus far, few HSR systems pay their full operating costs, much less pay back their initial capital costs. Dick Soberman, a Civil Engineering Professor at the University of Toronto joked if we wanted to make symbolic statements about our community, we should build Pyramids rather than rail lines, since the Pyramids have lower operating costs.

Some individual HSR lines may cover the cost of running trains, but not the cost of infrastructure. The idea of profitability is nonsense.¹¹ If this were to be private, following the history of most transport infrastructure investments, the first generation of investors are likely to be wiped out in bankruptcy. Governments do not typically go bankrupt, they just borrow from other sources, tax, or reduce spending elsewhere.

Some favor subsidy, but the argument for a subsidy for a mode serving people undoubtedly of above average income (inter-city business travelers) has no basis in equity reasoning.

Reducing congestion also seems a spurious argument, since most congestion is urban, and that would possibly justify subsidies for non-highway urban transport, but not for non-highway inter-city transport. Air transport, the dominant mode of longer distance travel, is on the order of 10% of total highway travel. Even if inter-city travel were somewhat congested, that argues for pricing the congested mode more appropriately, not for subsidy. The environmental argument is also a straw-man, comparisons need to be made between auto and air transport 20 years from now, not today's, and for much less than \$2 trillion, a lot could be done in those sectors. The source of electricity could be clean if we so chose, with adequate investments in new nuclear, wind, or solar generation.



Figure 15.9: Seattle Hub (Eugene - Portland - Seattle - Vancouver, BC) Network by Washington State Department of Transportation, Oregon State Department of Transportation.



Figure 15.10: Ohio Hub Network by Ohio Rail Development Commission.

¹¹ We cannot explain the irrationality of markets, but refer to some excellent papers by colleague, mathematician and transport and internet historian Andrew Odlyzko ([Odlyzko 2010a,b](#)).

¹² With the ideal spot being the apartment next to the Elevated Trains in Chicago, as in *The Blues Brothers*.

One cost people rarely talk about is noise, yet the noise externality is much larger for rail than for other modes. Fast trains are loud and infrequent, and so don't generate the white noise that neighbors of highways can more readily adapt too. While a five-year old fan of *Thomas the Tank Engine* may be happy living next to a rail line,¹² most people would not.

We also need to consider the opportunity cost of using tracks for passenger transport. This means they cannot be used for freight. Europe moves a greater share of freight on trucks than the US, while the US employs more trains. If the US wants an HSR network, it will have to take freight tracks, thereby making the cost of rail-freight relatively more expensive (and if we do reduce congestion, the relative cost of highway travel less expensive) moving more freight onto trucks. While this benefits the trucking industry, it does not benefit society at large.

In end we need to ask what is the best investment of \$2 trillion. Is it in transport? If it is in transport, urban or intercity? Freight or passenger? Which corridors? Which modes best serve those corridors given the transport network they are embedded in? If you had \$2 trillion what would you spend it on?

15.3 Nationalize the rails

Continuing on thoughts on high-speed rail, we get to the question of rights-of-way. Acquiring rights-of-way for new HSR corridors is likely to be expensive. The owners of the best rights-of-way are freight railroads. Of course many of those lines are used for freight travel.

¹³ Warren Buffett's Berkshire Hathaway purchased BNSF in 2008 for an estimated \$28 billion. The 2018 \$72 billion value is estimated.

As shown in Table 15.1, these six RRs¹³ could have been purchased in 2008 for a mere \$122.5 billion, and could be had for \$336 billion in 2018. This price tag is apparently nothing in the modern world of Washington, and less than the market value of Apple, Inc.

Table 15.1: Market capitalizations (\$ billions) for major US railroads. Source: Yahoo Finance.

Railroad	2008	2018
Burlington Northern Santa Fe (BNSF)	28	72
Canadian Pacific (CP)	9.7	29.4
Union Pacific (UNP)	38	111.1
Norfolk Southern (NSC)	22	48.6
CSX (CSX)	21	63.5
Kansas City Southern (KSU)	3.8	11.7

Then, the good passenger tracks for both HSR and urban transit could be stripped, and the remainder of the railroads re-privatized for some large (but not quite as large) sum of money.

Undoubtedly this would be cheaper than negotiating for lines on an individual basis. To illustrate, the cost of merely running rights for Minnesota's Northstar Commuter line on BNSF track for about 60 km,¹⁴ plus paying BNSF to operate the train was \$107.5 million. This is not grade separated, and even more importantly, passenger operations share tracks with freight, prohibiting high-speed operation.

¹⁴ 40 mi.

So one way to get an HSR system in the US at less cost than building new is to nationalize the freight railroads and strip them of right-of-way, rather than negotiating piecemeal.

Mind you, we do not think this is a good idea.

15.4 Supercities

An argument could be made about strengthening intercity linkages to refashion the current metropolitan system into a megalopolitan system, where people more regularly interact between cities. We might think of this as Switzerland writ large. The California HSR, if it ever actually connects to San Francisco or Los Angeles opens up California's Central Valley cities, places like Fresno and Bakersfield among others, as suburban bedrooms for coastal cities which don't want to *rezone*¹⁵ to increase housing locally.¹⁶

Since the division of labor is limited by the extent of the market, and transport can be used to expand the market, the division of labor can therefore increase (i.e. be more specialized), which should have some positive effects for the economy (akin to agglomeration economies). The magnitude of this is uncertain (and certainly location-specific), but presents the best case that can be made in favor of HSR in the US.

That said, remember that real HSR¹⁷ is a long term deployment, so it needs to be compared with cars 10 or 20 or 30 years hence, and the air transport system over the same period. Cars are getting better from both an environmental perspective and from the perspective of automation technologies. Autonomous vehicles need to be bested to justify HSR. Cars driven by computers should be able to attain relatively high speeds (though certainly not HSR speeds). Further they may move less material per passenger than HSR (trains are heavy), so on net may have fewer environmental impacts. This really waits to be seen.

¹⁵ §13.

¹⁶ It is worth noting that the HSR will only expand Central Valley commuting (and thus development) a small amount. The early 117 million passenger/year forecast implies about 320k trips per day. If all of them were commuters (and most aren't) it's 160k people. Hardly worthwhile for 'unlocking' California's Central Valley.

¹⁷ Real HSR is not the short term improvements to get to 160 km/h, (in the US context ranging from 90 to 110 mph) which may or may not be a good thing, but is certainly not HSR.

Sometimes the best travel choice is to not travel at all. A study sponsored by AT&T Inc. and conducted by the Carbon Disclosure Project estimates that skipping business trips and using video conferencing instead could save \$19 billion a year.¹⁸

¹⁸ (SVBJ 2010).

The study also said that by 2020 companies in the US and UK that have more than \$1 billion in revenue could cut CO₂ emissions equal to taking about 1 million vehicles off the road for a year.

Clearly teleconferencing is getting better and presents opportunities to achieve many desirable transport goals. Although institutions are lagging individuals, we regularly video-conference with our parents, and Apple's FaceTime, as one example, has made teleconferencing easy and portable. Making teleconferencing work when dealing with government agencies (or many private firms, or any bureaucracy) is more difficult. Any opportunity to avoid the hassle and headache of most business travel would be greatly appreciated by many travelers.¹⁹ As hockey great Wayne Gretzky said "Skate to where the puck is going to be, not where it has been."

¹⁹ We'll leave aside what would happen to airlines and publicly owned airports if there were a large drop in business travel.

Value Capture and the Virtuous Cycle

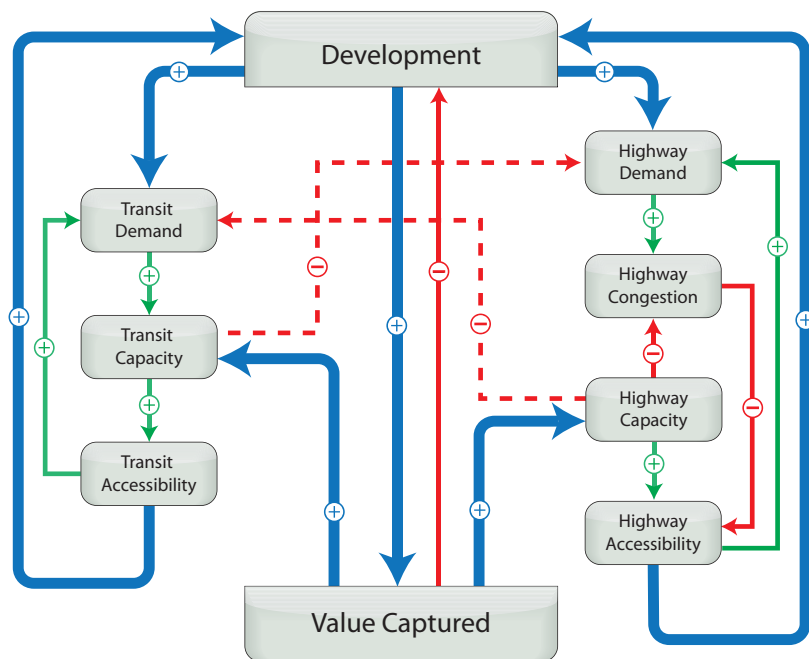


Figure 16.1: The virtuous cycle of development, accessibility, value capture, and infrastructure (Iacono et al. 2009).

This chapter¹ argues that infrastructure creates access, access creates value, value can be captured, and captured value can finance infrastructure to create further access and thus value. We call this a 'virtuous cycle,' as it describes a positive feedback loop: more of A begets more of B, and more of B in return results in more of A.

¹This chapter modifies, updates, and adapts parts of (Levinson and Istrate 2011), published by the Brookings Institution.

16.1 *Infrastructure creates access*

Well-located transport infrastructure creates access. A good example of this is the I-35W Mississippi River Bridge in Minneapolis, which collapsed tragically on August 1, 2007. The bridge was rebuilt and a replacement was opened on September 18, 2008. Figure 16.2(a) shows the change in number of jobs reachable by car in the morning peak period within 20 minutes with and without the bridge. The areas in red saw an increase in accessibility with the bridge, the areas in blue saw a decrease. Although not immediately apparent, overall the bridge added accessibility. It is important to note that it did not add accessibility for everyone, as traffic patterns altered, some links saw more traffic, some saw less, and consequently lower and higher speeds respectively. Any piece of infrastructure creates winners and losers; we hope that both the absolute winnings, and the number of winners, exceeds the losses and number losers.

² The additional lane was obtained mostly by converting the bus-only shoulders to general purpose traffic.

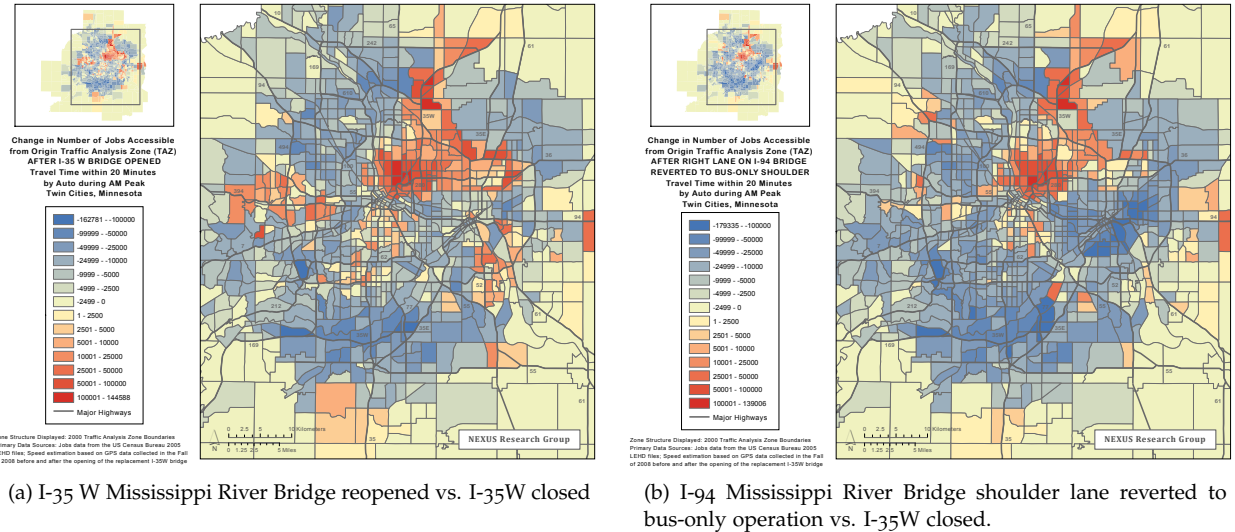
This link, while important, was not as important at this time-of-day as an additional lane on I-94, which had been added² in response to the bridge collapse by the Minnesota Department of Transportation as a traffic restoration project. Several weeks after the replacement I-35W bridge opened, this additional lane on I-94 was reverted to operations as a bus-only shoulder. Figure 16.2(b) shows the accessibility loss associated with reverting this lane.

While the I-35W bridge illustrates a project that could be built quickly, if only because of the unusual exigencies of that case, in practice new urban infrastructure is politically difficult and time consuming. Even in a mature network, significant connections' benefits fail to outweigh their costs, which cannot be completed due to lack of funds.

A second example is the Hiawatha LRT line running from downtown Minneapolis to the Minneapolis-Saint Paul Airport on to the Mall of America. It too created access after it opened in 2004. A study³ of the effect of the Hiawatha LRT, and other transit improvements in the Twin Cities between 2000 and 2005 shows significant improvements in access to low wage jobs, as shown in Figure 16.3. There were also improvements in access to high-wage jobs, those are not shown here.

³ (Fan et al. 2012).

The authors argue that transit improvements resulted in significant increases in accessibility by transit, both in the Hiawatha corridor, and in other corridors where high-frequency bus service was enhanced during this period. The large part of this change is due to the changes in the transit network rather than changes in land use, which were relatively modest, and mostly occurred in



transit-inaccessible parts of the metropolitan area. The authors could not disentangle how much was due to the LRT alone, since the LRT was implemented concomitant with restructuring of competing and complementary bus routes. Another study of the Green Line LRT showed most of the benefits were due to the concomitant bus restructuring rather than the LRT itself.⁴

The authors also found, using Census Longitudinal Employment Household Dynamics (LEHD) data which records the home and work block of all workers in the region, that commute flows reorganized after the introduction of LRT and other transit improvements so that more trips originating within a 400 m^5 of transit stations terminated near transit stations. This in particular occurred for low income workers and low income jobs. While this data does not directly report mode use, it indicates that commuters will orient their activity patterns to take advantage of available transport services.

16.2 Access creates value

As noted by the [quotes from Adam Smith](#),⁶ accessibility is a socially produced benefit accruing both to the community at large and, in large part, to private landowners. All access value comes from the ability to reach things off-site, that ability is determined by the pattern of development and the transport network. Without access, land only has value due to its natural resources, and property due

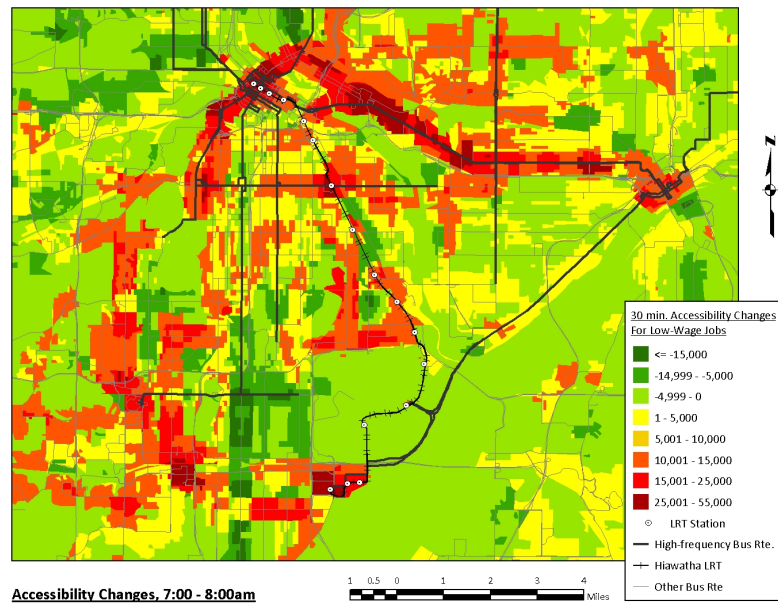
Figure 16.2: Difference in absolute accessibility to jobs within 20 minutes by car (2008 data) with and without I-35W Bridge. AM peak period 6:30 - 9:30 am. Travel times estimated using GPS.

⁴ (Owen and Kadziolka 2015).

⁵ Approximately one quarter-mile.

⁶ §1.1.

Figure 16.3: Difference in absolute accessibility to low wage jobs reachable within 30 minutes by transit with and without the Hiawatha LRT and other transit routes (2000-2005 data), 7:00 - 8:00 am period. Note: other changes occurred to transit network in addition to the new Hiawatha LRT. Source: (Fan et al. 2012)



to any structures placed by land owners. The beneficiaries of transport can be associated with three groups:

1. *Travelers*, who benefit from every trip they make (otherwise, why travel). On state and federal roads, the gas taxes pay for most of the costs of operating, maintaining, and building road infrastructure. They do not recover the benefits, which remain with travelers.
2. *Land owners*, who receive value from the ability to access other sites (whether or not they are actually accessed). This is illustrated by the changing rents as one moves out from the center of town. There is generally a rent premium, because at certain sites one need spend less time in travel to obtain benefits. We see rents embodied in construction when buildings are taller in central areas, those areas where one can reach the most activities in the shortest time. Land value captures much of the benefit of infrastructure.
3. The *Public* at large gains from spillovers that are not captured by travelers or land owners. The public benefits from a well-connected population.

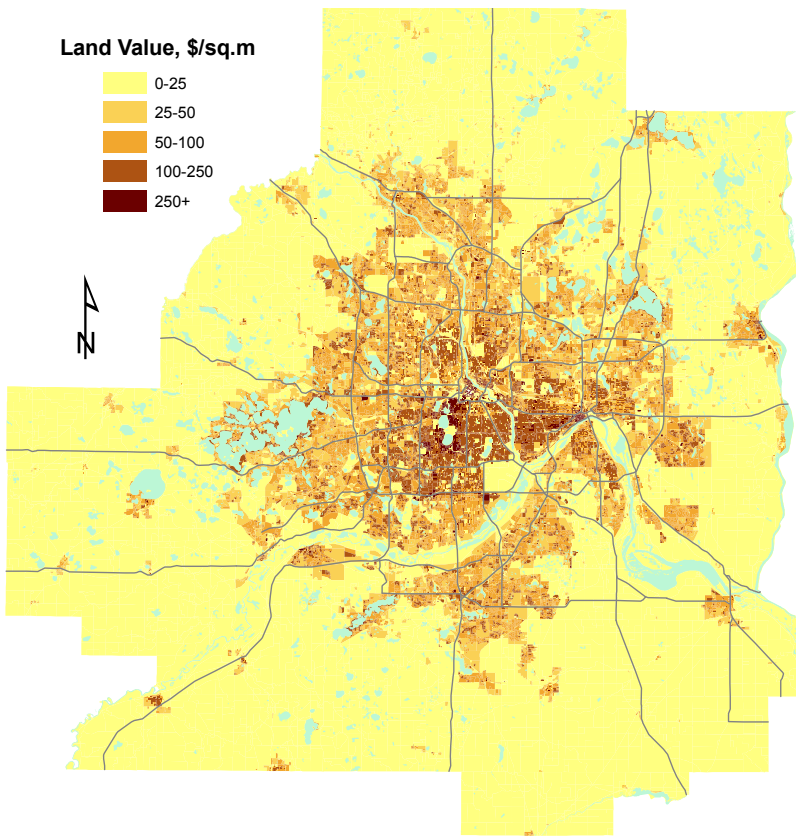


Figure 16.4: Land Value in the Twin Cities region, $\$/m^2$. Source: Developed as part of Junge (2009).

The evidence that access creates value comes from a variety of empirical studies showing the relationship between property value or rent and various measure of accessibility.⁷ Figure 16.4 shows the pattern of land valuation in the Twin Cities: land is at a premium in the downtowns, at major interchanges, and adjacent to important amenities like the Chain of Lakes.

⁷Garrison et al. (1959) is one of the first of such studies, hundreds of studies supporting this have followed.

16.3 Value can be captured

Current transport funding is a mix of federal, state, local sources, and a mix of user, non-user beneficiary, and general public revenue sources.⁸ While a large part comes from user fees collected at the state level, local transport funding largely depends on local general funds (which are often property tax based) as well as specific dedications from property taxes. Each state differs in this allocation, but the general pattern remains that many funds, especially for local transport, are funded based on property value rather than user fees.

⁸Detailed data for Minnesota can be found here: <http://tpec.umn.edu/research/finance/MNTF/data/>.

Figure 16.5: Value capture mechanisms summary.

	Development	
	New	Existing
New (Expansion)	Case 1 Impact fees, Joint development	Case 2 Special assessments Tax increment financing
Existing (Preservation)	Case 3 Air Rights	Case 4 Land value tax Transportation utility fees

The economic rationales for reliance on local property tax revenue are several. Roads are a necessary public function: we had public streets and roads before the automobile and will have public rights-of-way after the last car. Roads enable people to move on the surface, enabling services from emergency vehicles to the mail, in addition to personal travel. The property tax can be seen as a charge to have access to the system, independent of use. The property tax is collected in any case, so using an existing revenue source is administratively efficient for local governments. Finally, in the absence of congestion, roads are dominated by fixed costs rather than variable costs, meaning the cost is largely independent of use. While we support full cost road and transit pricing, in the absence of that, we still need solutions.

Any revenue source makes trade-offs between administrative efficiency, equity, political acceptability etc. There is no universal best mix of funds, it depends very much on the context of the specific place and time. That mix has to deal with several inter-related problems, including funding both operations and maintenance and funding capital expansion, which have different requirements.

The term *value capture* refers to a family of public finance mechanisms that raise funds in proportion to the increase in land value associated with new or improved public infrastructure. These mechanisms can be applied to new or existing development and can fund new or existing infrastructure, paying for either capital or operating costs. Several of these mechanisms are defined and described below. There have been numerous papers reviewing aspects of value capture, and effectiveness, and properly implemented any of the mechanisms described below may have a role.⁹

⁹ Reviews of the literature on value capture include (Smith and Gihring 2006; Zhao et al. 2012; Batt 2001; Cervero and Duncan 2002; Rybeck 2004; Gihring 2001; Cervero and Duncan 2002; Rolon 2008).

- Case 1: New development, new infrastructure (expansion)

- *Impact fees* can ensure that new infrastructure required to support new land development is paid for by that new development. These charges may be established in a number of ways, so long as a legal nexus can be found which ties the need for the new infrastructure to the new development. These fees range widely. In suburban Maryland, where 16 counties have an impact fee or development excise tax. For example, Anne Arundel County charges \$11,400, while Prince George's County charges from \$8,177 (inside the Capital Beltway) to \$14,019 (outside).¹⁰ These impact taxes pay for identified nearby master planned roadways which otherwise could not be built in a timely manner, thereby ensuring public facilities are adequate. In places with adequate public facilities ordinances (APFOs), subdivision is not approved without passing an adequacy test. ¹⁰ (Halsey III 2008).
- *Joint development* describes several related ideas: jointness in location, timing, and organization. In all cases the term describes development adjacent to (or on top of) a piece of infrastructure which serves it, such as a transit station or a highway interchange. Development may be built by the same organization (public or private) or may be coordinated by different parties, with the land development cross-subsidizing the infrastructure.
- Case 2: Existing development, new infrastructure (expansion)
 - *Special assessments* can fund improvements whose benefits accrue to existing development. A district around an identified project would receive a special assessment to fund in part or in whole a new piece of infrastructure. This technique is widely used for funding streetlights, repaving, sidewalks, and the like, but has also been extended to funding transit stops. The Portland Streetcar was the product of a special assessment district around the line.
 - *Tax increment financing* funds an infrastructure project by borrowing against the future stream of additional tax revenue the project is expected to generate. For instance, an interchange serving the headquarters of Fortune 100 retailer Best Buy in Richfield, Minnesota was financed by the company in exchange for the right to keep future property tax increases that otherwise would have gone to the city.¹¹ The company gets the interchange, the city is hopefully no worse off (since without the development, it would not have received the property tax anyway), and likely better off if the project has ¹¹ (Pristin 2005).

¹² The project also controversially used eminent domain to acquire successful car dealers for the construction of the Best Buy headquarters, which complicates the case.

¹³ Lari et al. (2009); King et al. (2008).

¹⁴ Junge and Levinson (2012a); Kwak and Mak (2011); Dye and England (2009).

¹⁵ Junge and Levinson (2012b).

any positive spillovers on other properties within the metropolitan area.¹²

- Case 3: New development, existing infrastructure (preservation)
 - *Air rights* capture the real estate value of transport by selling or leasing the space above (or below) transport facilities for development.¹³ Typically this is after-the-fact of the construction of the roadway, transit station, or rail line, so it recovers value after creation, though it could be applied simultaneously with infrastructure creation and in that case be a form of joint development.
- Case 4: Existing development, existing infrastructure (preservation)
 - *Land value taxes* reform the property tax by separating the value of a property associated with land from that associated with the structure.¹⁴ Since the value of the land is determined by its accessibility, which is created by the community at large through construction of transport networks and location of activities, a tax on only the value of land captures benefits of transport more directly than a tax on both land and structures. Such a system may also have beneficial side-effects of encouraging development of valuable land like surface parking in urban cores, which is now discouraged by the tax code.

There are a variety of mechanisms to capture that value and dedicate it to public infrastructure to harness this virtuous cycle. The property tax is the most basic and primitive form of land value capture. The foremost critique of its use as a land value capture tool is that it captures both the value of land and the value of structures built on the land. The value of the land is determined by its relative location to other activities (or its use in farming or resource extraction, but those are moot in urban areas). That relative location is created by the government and by the community as a whole. The value of structures in contrast arises from the investments made by land owners. As a land value capture tool, it makes sense to disentangle these two aspects of property.
 - *Transport utility fees* replace the share of general fund tax revenue going to transport with a charge that is roughly proportional to expected transport use.¹⁵ An example would be to use standard trip generation rates as the basis for

charging rather than using property improvements. This better ties benefits to costs, though still does not send a signal to reduce transport use, the way a more comprehensive user fee would (i.e. a charge based on actual rather than prospective use). However, it would be much simpler to implement, and therefore has greater administrative efficiency if the only aim were funding rather than managing travel demand.

16.4 Captured value can fund infrastructure

The new revenue sources identified above can fund the construction, operations, and maintenance of important infrastructure. For the highway network, which is largely mature, revenue is most needed to operate and maintain existing facilities. This is a way of preserving infrastructure (and thus accessibility) already built, ensuring we do not slip backwards by allowing important facilities to deteriorate to the point of failure.

The techniques mentioned above have been used in various places to fund some transport services, none have been fully deployed to achieve their potential. The land value tax for instance has been used in Hawaii, is still used widely in Pennsylvania, and in other countries, but not widely in the rest of the US. Transport utility fees are widely used in Oregon, and have seen limited use in a few other states. Impact fees are used in more than half the states. Tax increment financing has been favored in the Midwest and on the West Coast. Joint development is used widely in Asia, and sporadically in the US around selected transit lines (such as Portland, Miami, Philadelphia, Washington, and New York). Air rights have similarly been used on transit systems (for example Atlanta, Washington, and Boston), but also above Interstate highways, in many cases for parks, though for development as well in high density areas.

The reasons for popularity of different mechanisms are likely as much an accident of history as opposed to any structural factors. Good ideas diffuse, first locally, and then elsewhere if there is a need. But there must also be advocates, and disrupting existing political equilibriums for a new financing mechanism are difficult to achieve.

16.5 Policy implications

Value capture is a set of techniques for associating benefits and costs. It is most often used as a source of local funding, tying the local beneficiaries to the local costs. Impact fees, joint development,

special assessments, tax increment financing, land value taxes, transport utility fees, and air rights are among the most widely discussed forms of value capture, and all have advantages and disadvantages from policy and political perspectives.

The value capture techniques suggested here apply primarily to local governments, though there may be state and national analogues to value capture. The first difficulty is that local transport planning (particularly for larger facilities) is conducted at the state or metropolitan levels, while land use is generally controlled at the township, town, city, or county level of government. This is a classic [correspondence problem](#).¹⁶

¹⁶ §17.1.

Value capture, which explicitly ties infrastructure funding to land use policy, can provide the incentive for agencies to coordinate, and can provide the revenue stream for local governments to pursue more substantial transport projects without being at the mercy of higher levels of government. States need to ensure that localities have the legal authority to implement these strategies if they so choose. Successful implementations will be emulated – ideas are light baggage – and unsuccessful policies will be abandoned.

Value capture can replace existing sources of local transport finance that assess costs independent of the magnitude of benefits.

CAPITAL COSTS FOR NEW OR REBUILT TRANSIT SYSTEMS SHOULD BE RECOVERED FROM LAND VALUE CAPTURE. Transit services create value they cannot fully capture themselves through the farebox (though they would capture more of this with higher fares). That value spills over to nearby land owners, whose property value increases due to the accessibility transit provides and thus the higher rents they can charge. The amount of value captured by the system signals whether the investment is worth making. If some of that value were captured, more revenue would be available to make investments. Transit utilities should have the authority to develop land at stops and stations, and to develop air rights over their tracks, and to contract with private developers to coordinate station locations. Local units of government desiring routes and stations should have the authority to implement local taxes to subsidize the transit utility for the cost of building the line. But the line should only be built if it can at least break even operationally. If the route cannot be funded from land value capture and farebox revenues, it should not be built.

CAN THE US GET VALUE CAPTURE RIGHT? New York City, Kansas City,¹⁷ Chicago, Los Angeles, Dallas, Minneapolis and others have all pursued some type of value capture for transit and/or roads. Now the US DOT looks favorably at projects that use value capture when considering what to fund.¹⁸ Yet for all of its promise the US experience offers mixed results, at best, and at worst is just another example of pernicious rent seeking and inadequate representation.

Here are three examples of value capture gone wrong that deserve further study:

- *Hudson Yards and the 7 Line Extension, New York City*: The city pushed forward with an extension of the 7 subway line to the west side of Manhattan. To expedite the process the city avoided federal funding and associated federal rules and regulations. Local funding was through a Tax Increment Finance (TIF) district managed by the Hudson Yards Investment Corp. The NYC IBO released a report that detailed how the TIF was not generating as much revenue as expected. Related Companies will actually get a subsidy up to \$328 million to build in the TIF district.¹⁹ Subsidizing development is, of course, exactly the opposite of capturing increased property values.
- *Los Angeles Downtown Streetcar*: The residents of part of downtown voted to tax businesses based on their location to the streetcar. Having residents vote to raise specific taxes on targeted populations that can not vote (businesses in this case) raises questions of representation, but even more problematic is that the streetcar project has changed for the worse as it is more expensive for less service. That's not what people voted for, and now, as with the New York case above, the city will likely have to pick up the balance of the costs above and beyond any value capture mechanism.
- *Chicago's Morgan/Lake CTA Station*: This station was paid for through a TIF and is credited, *ex post*, with reviving the neighborhood. Of course, the reason the station was planned there was that the neighborhood was already attracting lots of development.²⁰

In 2002, the Chicago Department of Transportation (CDOT) investigated the feasibility of constructing a new infill station to boost train ridership and encourage economic growth along the Lake and South Side branches of the Green Line. Morgan Station, with its recent influx of residential and commercial development, was chosen as the optimal station location. The 2006 construction of the Pink Line, which will also be serviced by the new station, was also a consideration in the final decision.

¹⁷ Also with regard to representation, it is worth noting that only 351 people voted in favor of the property tax to pay for the Kansas City streetcar. Direct democracy is no way to manage collective goods. We elect representatives for a reason – to represent. But this deserves much more space and time than can be supplied here.

¹⁸ (Rose 2013).

¹⁹ (Levitt 2013).

²⁰ Quote from Center for Neighborhood Technologies (Center for Neighborhood Technology 2012).

It is great that investment follows demand, it is a good way to build a great transit system. But it does call into question economic development claims, and a TIF in this situation may skim off property taxes that would otherwise have gone to the city's general fund. The TIF situation in Chicago is already problematic, though. Google is moving to the neighborhood, too, which is viewed as new development even though Google is already in Chicago in a nearby location. We will also note that even though Google considers transit access a plus, as mentioned here, they are moving from a neighborhood with about the same level transit access. What really improves with Google's new location is freeway access.

Ultimately, value capture is promising but also vulnerable to abuse (like all things). Value capture is not a panacea. For whatever reason, US cities and states too often enter into contracts that are neither decent nor fair to the public purpose. This is a generalization, but the US does privatization, contracting out, and cost controls worse than most other countries with mature economies. We worry that value capture will end up added to this list of things the US can't get right.

Part IV

Institutions

The many problems besetting roads and transit exist not because the solutions are unknown, we identify many in earlier chapters, but because the institutions that currently exist are incompatible with those solutions. Our strongest recommendations are therefore institutional. Get the institutions right, and better solutions can be more easily implemented. That said, there are reasons institutions are the way they are, and other institutions constrain the ability to reform transport institutions. But there is also a blind-spot in politics, taking institutions as given (which they are in the short run), and accepting our fate as inevitable. We reject that, and can point to other countries with better institutional structures.

Devolve Responsibility

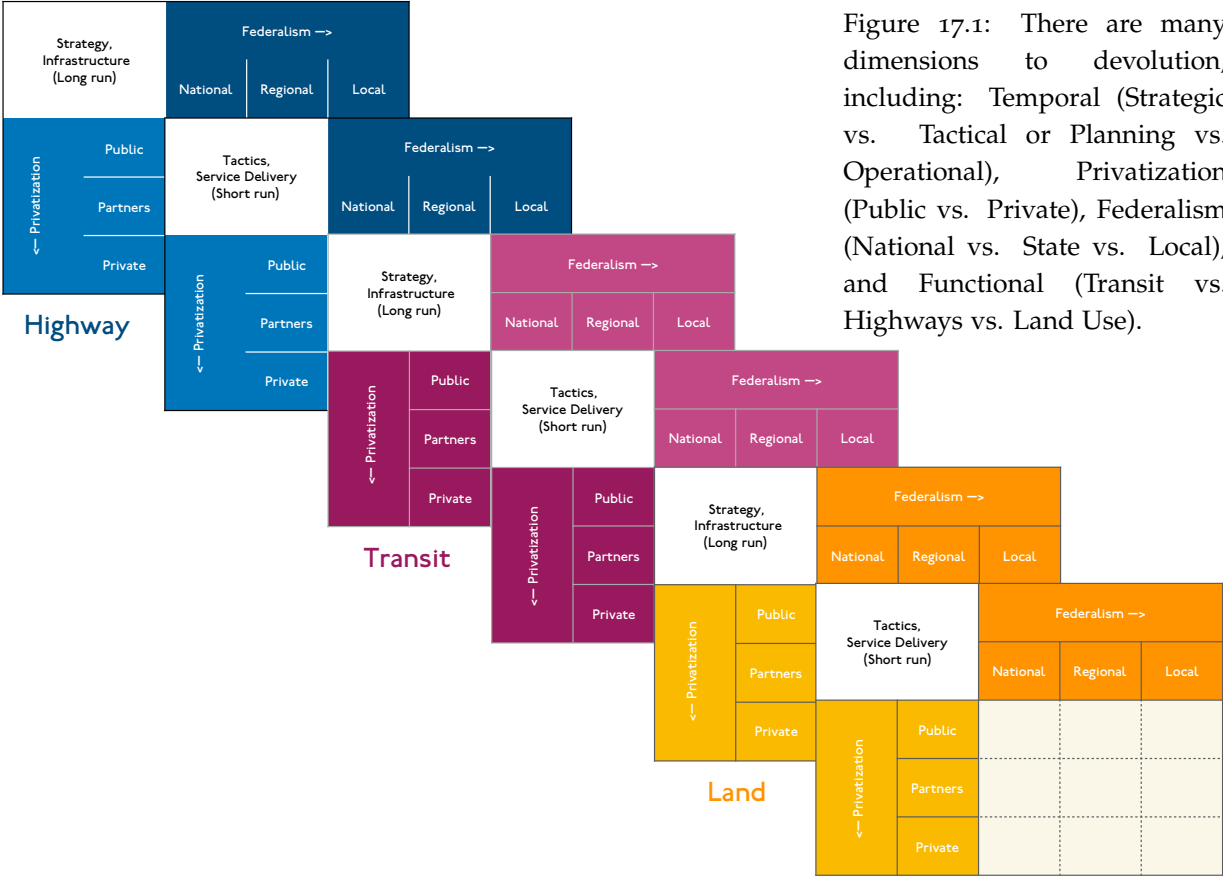


Figure 17.1: There are many dimensions to devolution, including: Temporal (Strategic vs. Tactical or Planning vs. Operational), Privatization (Public vs. Private), Federalism (National vs. State vs. Local), and Functional (Transit vs. Highways vs. Land Use).

Transport is planned at many scales. Land use less so, at least in the United States. Transport policy is equally likely to be federal, state (provincial), metropolitan, or local. The governance scale is

influenced by mode to a degree; where the faster and longer distance of travel, the more likely it is to be a concern of the federal government (think air traffic control) and the slower and shorter distance traveled modes are local concerns (think sidewalks). There are obviously exceptions to this, but it works as a starting point for a discussion of the appropriate governmental scale and scope for transport.

Transport investment confers benefits through accessibility. A road that connects Springfield and Shelbyville benefits both cities – perhaps not equally – and can be planned and paid for as such. The same case can be made for air travel or rail travel that improves access between pairs. A new sidewalk in Springfield does nothing for pedestrian accessibility in Shelbyville, however, which suggests that Shelbyville shouldn't pay anything for that improvement. On a simple network, we can fairly easily assign costs and benefits. When the network is complex, such allocations are more difficult.

What is the benefit to a resident of Arizona of the road used in Colorado? It's not nothing – Arizonans value being able to travel north and receive goods from elsewhere. But an Arizona road is more valuable to Arizona than a Colorado road is to Arizona. What about transit? A better transit network in Phoenix has scarce value in Denver. These examples suggest that under a beneficiary pays model (not simply user pays) taxes and fees used for investment should focus on where benefits accrue.

The federal role in transport policy has changed over the years. Since the advent of the Interstate network, the federal government used its power of the purse to prioritize investments. For decades federal priorities became state and local priorities as the money provided was too tempting to ignore. Federal sway was not limited to physical building, either. In the 1980s the Reagan administration tied any federal transport spending to states adopting a Mothers Against Drunk Driving (MADD)-favored stricter standards for drunk driving. All states quickly complied.

Relying on a strong federal role has drawbacks. The biggest issue is that there are few national priorities in transport and land use. Instead, there are many local priorities. The Interstate system was clearly a national concern. That the network was built through cities was in part because of the federal cost share where the US federal government paid 90% of the costs of construction. Even Robert Moses in New York City, who favored toll roads under his control to ensure political independence, couldn't resist the federal Interstate program and its 90 cents per dollar spent. He quickly developed

plans for Interstates through lower Manhattan. Fortunately for the city, Jane Jacobs helped organize opposition and stopped him.¹

¹ (Caro 1974).

Since the early 1990s, the federal role has changed toward greater state and local control. Unlike the United Kingdom's policy of devolution, which pushed power to cities and regions intentionally, the US devolution experiment is a bit more accidental.² The Intermodal Surface Transportation Efficiency Act (ISTEA) legislation was passed in 1991, of which one goal was to give state and local flexibility about spending priorities.³ Another was to encourage private investment in transport, such as allowing federal money to be spent on tolled roads. The push to devolve the federal role through ISTEA didn't really work, however.⁴ There are many reasons for this, but the first clue as to why is that the federal fuel tax rate, the revenues of which are used to support the Highway Trust Fund, hasn't been increased since 1993. The federal commitment has been flat or shrinking in terms of purchasing power since then. Funding formulas that returned almost all fuel taxes to the state where they were collected prevented redistribution, and federal spending is primarily for capital expenses while operations and maintenance are the responsibility of state and local governments.

² (Campaign for Better Transport 2014).

³ (Puentes 2011).

⁴ (Snyder 2011).

What has happened in the years since ISTEA is that federal money is harder to get, comes with strings attached and is spent on infrastructure that will strain operations and maintenance budgets at some point in the future.

17.1 *Subsidiarity*

The idea of *subsidiarity* requires addressing social and political issues at the most local level that can resolve those issues. The reasons for this are several, including efficiency, motivation, and information. Local stakeholders will know and care more about issues and solutions than remote actors, as they have, and will continue to live with the problem and its aftermath.

This principle is enshrined in European Union law. The Tenth Amendment to the Constitution of the United States also implicitly subscribes to the notion of subsidiarity.

The powers not delegated to the United States by the Constitution, nor prohibited by it to the States, are reserved to the States respectively, or to the people.

In the context of transport, states are closer to travelers than the federal government, and from a federalism perspective, to minimize off-diagonal outcomes in the correspondence problem illustrated in

⁵ §4.

		Loci of Issues		
		National	Regional	Local
Loci of Authority	National			
	Regional			
	Local			

Figure 17.2: The spatial policy correspondence problem: loci of authority vs. loci of issues.

⁶ (Levinson and Zhu 2012).

Figure 17.2 (that is making sure local problems are addressed locally and national problems are addressed nationally), and from the idea of subsidiarity, placing these [subsidies](#)⁵ at lower levels of government has advantages, but there is no objective reason why, e.g. Amtrak’s funding from one level of government is revenue and the other is subsidy.

It turns out that most travel is local. Using GPS data for Minneapolis - St. Paul commuters, we found that the share of automobile travel occurring in the county of residence was more than 70% for both county and city streets.⁶ It is likely higher for modes like walking, biking, and public transport with shorter average trip distances. So while there is inter-county travel, it is small compared with intra-county travel, and suggests, following the principle of subsidiarity, that most roads and transit services that can be, should be locally managed. We can debate whether local means municipally, county-level, or metropolitan, and the correct answer depends on administrative boundaries and jurisdiction size. But it does not mean nationally in a country the size of the United States.

17.2 *Ending the federal surface-transport program*

Since most travel is local, we can ask: What should be the appropriate federal role for funding and prioritizing transport? Should the United States end the federal gas tax entirely, phase it out, keep it at the same rate, or raise it? There are proposals for all of these.

⁷ (Salam 2013).

Reihan Salam writes:⁷

So far, the most attractive realistic proposal for reforming federal highway expenditures is *Fix It First*,⁸ *Expand It Second*, *Reward It Third: A New Strategy for America’s Highways*⁹ by Matthew Kahn and David Levinson, which calls for the following:

First, all revenues from the existing federal gasoline tax would be devoted to repair, maintain, rehabilitate, reconstruct, and enhance existing roads and bridges on the National Highway System. Second, funding for states to build new and expand existing roads would come from a newly created Federal Highway Bank, which would require benefit-cost analysis to demonstrate the efficacy of a new build. Third, new and expanded transport infrastructure that meets or exceeds projected benefits would receive an interest rate subsidy from a Highway Performance Fund to be financed by net revenues from the Federal Highway Bank.

⁸ §3.3.

⁹ (Kahn and Levinson 2011).

Rohit Aggarwala of Bloomberg Philanthropies¹⁰ has called for a

¹⁰ See (Aggarwala 2013).

more radical approach, which might garner bipartisan support while forcing believers in competitive federalism to ‘put up or shut up.’ ... Aggarwalla calls for abolition of the federal gasoline tax and the devolution of responsibility over surface transport to state governments:

Getting rid of the tax would force a serious discussion in each state about how, and how much, to fund roads and transit. States could choose to reimpose the same tax, or they could set a different rate based on their desired level of transport spending. They could choose to raise other kinds of revenue to pay for roads and transit – such as sales taxes, property taxes, local taxes or tolls. Or they could simply reduce their transport spending.

In the wake of the periodic US surface transport reauthorization bill it is worth reflecting on “Why is there a federal role?” In short the argument against are that the system exists, most traffic is local,¹¹ and the states are perfectly capable of managing and preserving the system, since they already do. All they need to do is raise their gas tax by the amount the federal tax is reduced, and they are no worse off, assuming all federal transport funds come from the Highway Trust Fund, which is less true than it used to be. The federal role could be reduced to research¹² and safety regulations.

One argument against the Aggarwala position is that it is needlessly cumbersome to to fight 50 gas tax fights in 50 states, there is a strong convenience of existing revenue source, and this greatly reduces political transaction costs, since it is the status quo.

A second argument against is that we essentially need to rebuild the Interstate in place, and this recapitalization is a national need, just as the initial construction was, justifying a national funding source. We would not want one state to let its existing Interstates devolve to rubble due to poverty, even if it mostly hurt them. We don’t think that would happen (at least not at a large scale), but clearly different states would have different investment levels without the federal minimum funds.

Avoiding 50 political battles and relying on the status quo funding (which is also an indirect user fee) for a few more years, and directing that existing funding, seems a good second-best solution, better than immediate complete devolution. Of course, one could argue that devolution might help force the transformation to a [utility-based](#)¹³ road sector, so this is not obvious.

For additional rationales for the highway program, read “The Rationale for Federal Aid” from 1985,¹⁴ which could have easily been written today. We have [learned nothing](#)¹⁵ in 30 (60) ((90)) years.

In this instance the bill being discussed was the Moving Ahead for Progress in the 21st Century Act, nicknamed MAP-21, but this is perennial. See e.g.

- Federal-Aid Highway Acts (1916-1987)
- National Interstate and Defense Highways Act (1956)
- Surface Transport Assistance Act of 1982 (1982)
- Surface Transport and Uniform Relocation Assistance Act (1987)
- Intermodal Surface Transport Efficiency Act (1991)
- National Highway System Designation Act (1995)
- Transport Equity Act for the 21st Century (1998)
- Safe, Accountable, Flexible, Efficient Transport Equity Act: A Legacy for Users (2005)
- Moving Ahead for Progress in the 21st Century Act (2012)
- Fixing America’s Surface Transport Act (2015)

¹¹ (Levinson and Zhu 2012).

¹² This might look self-serving as researchers, but research is a public good with positive externalities that we support in general, not just our own discipline.

¹³ §19.

¹⁴ (Gómez-Ibáñez 1985).

¹⁵ §14.3.

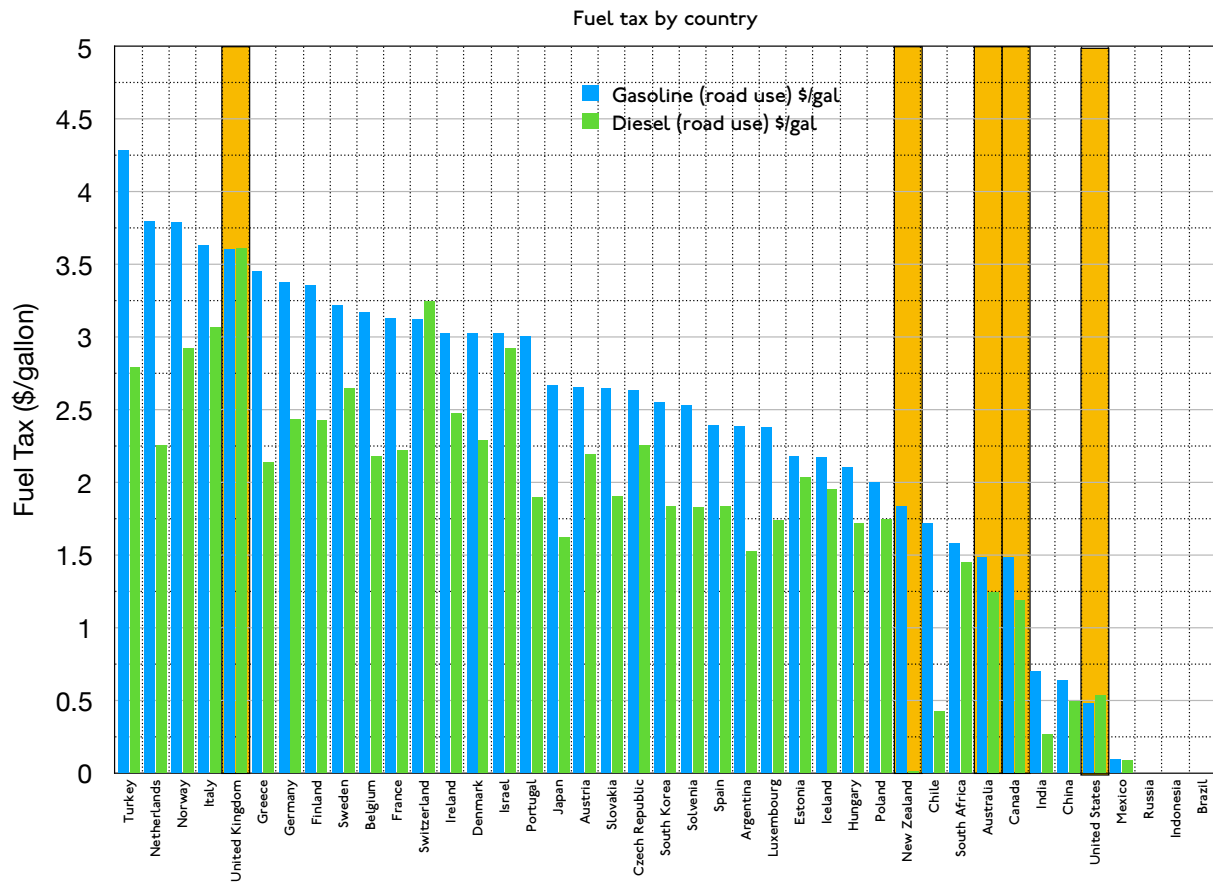


Figure 17.3: Fuel Tax Comparison. Source: OECD/EEA database on instruments for environmental policy. <https://pinedatabase.oecd.org>.
¹⁶ (Walker 2011b).

17.3 *Transport finance without the feds: The Canadian model*

Transit consultant Jarrett Walker makes a brilliant point about US transport financing prospects:¹⁶

“In other words, US urban policy would become more like that of Canada, a country where the federal role in most urban matters is much smaller than in the US, but where cities, regional governments, and provinces are correspondingly freer to chart their own way, and pay for it.

It’s easy to imagine that more conservative states would just let their cities die through underfunding, but that’s certainly not happening in Alberta. Canada’s most conservative province, a natural resource powerhouse that draws comparison to Texas in its boom times, has remarkably good inner-city transit policy and a continuous stream of provincial investment. Calgary’s downtown commuter parking cost is about the same as San Francisco’s and the

result is extremely strong ridership on its bus and light rail system, at least for commutes, and support for a dense core.

The transition to a more Canada-like federal role would be hell. Everyone involved is understandably horrified by the prospect, including me much of the time. But if the federal budget-slashers win, US cities and states will be on that course whether they like it or not. Are we sure the eventual outcome would be a disaster?"

The declining share of US federal money for transport finance has many people worried that transport policy and finance will devolve to the states. Such devolution of authority is viewed as a necessarily lousy outcome, especially by progressives.¹⁷ From our perspective, the status quo for transport policy and finance cannot be objectively defended as a success. Looking at the period of about 1971 (the year Amtrak was formed is a good marker of the beginning of the current era of federal policy, but just about any year between 1964-1974 works) to the present, US transport systems declined in nearly all measures of productivity,¹⁸ economic performance,¹⁹ social welfare,²⁰ or just about anything else you care to measure. For whatever occasional successes US policy has had, the US has received an extremely poor return on investments made. America can do better.

An experiment devolving transport policy and finance to the states is likely to improve overall performance of all aspects of transport. For evidence we can look to our chilly northern neighbors in Canada, who do not have anything equivalent to the US Department of Transportation. Transport policy is the responsibility of the provinces, and transit policy is the responsibility of the cities. So how do Canadian cities compare?

Table 17.1 is drawn from Paul Mees' work. The city regions are sorted by transit mode share. Every major Canadian region has higher transit mode share than US cities except New York, Chicago and San Francisco. The simple correlation between density and transit share is 0.48, so density does not adequately explain the differences. Canadian transit systems also have much higher farebox recovery ratios than in the US.²¹ The Toronto system has to maintain greater than 70% farebox recovery in order to receive subsidy for the balance.

A 2013 report on Toronto area transport finance explains the financing structures in place and potential future monies.²² The authors promote many taxes and fees, all of which are economically sound and focus on raising money for transport by charging those who benefit from a well-functioning transport system. Essentially, if the Greater Toronto-Hamilton Area needs new transport investment

¹⁷ Process arguments are often arguments of convenience. We discuss this in the section on the [Department of Accessibility](#), (§17.9.)

¹⁸ (Lave 1991).

¹⁹ (Drennan and Brecher 2012).

²⁰ (Fan et al. 2012; Garrett and Taylor 1999).

²¹ (Wikipedia contributors 2018c).

²² (Kitchen and Lindsey 2013).

to maintain and improve economic competitiveness, then they can and should raise the money locally.

²³ §19.2, (TransLink British Columbia 2013).

Local control can also lead to service innovations, such as [TransLink in Vancouver](#).²³ British Columbia instituted a carbon tax in 2008. There are certainly problems with the decentralized system. Some Canadians want a national transit agency. Fragmented governance in regions makes coordination difficult, and perhaps a stronger regional agency is needed. Most difficult, perhaps, is that many cities forego transit service altogether. However, eliminating unproductive transit so that resources can be used elsewhere is actually good policy. But by nearly every measure Canadian transport policy outcomes are superior to US outcomes. Whether US transport finance and policy devolves to the states remains to be seen, but it certainly isn't something that should be dismissed as inferior to what we have now. It may well be better.

²⁴ The Koch Brothers fund anti-transit political activities through their Americans for Prosperity group (Tabuchi 2018).

We shouldn't worry that transit will be abandoned without federal subsidy. In the United States there are conservatives who are anti-transit,²⁴ but this isn't necessarily the case for cities in conservative states. Oklahoma City is building a streetcar. Houston and Dallas have made substantial investments in new rail systems in recent years. While these rail investments would have likely not been made absent federal capital subsidy, these cities are also pursuing transit-oriented development, and, in Houston's case, a recent bus network redesign. Houston is one of the few cities with rising transit ridership in 2018.

²⁵ The MPO is a multi-jurisdictional organization mandated by the federal government for local areas to receive transport funding.

Canada does better than the US on many infrastructure investment questions. In the end, both the 'left' and the 'right' should welcome this outcome. Local governments, weened from Washington will make decisions that better fit local needs. Transit investment will increase in places where it should (and not where it shouldn't). There will remain intra-metropolitan investment mismatches, but a lack of federal dollars may also disempower the metropolitan planning organization (MPO).²⁵ At any rate, metropolitan mismatches are less odious than federal investment mismatches.

When the established interests start saying their 'ohs noes' about the shrinkage of federal funds, think about our neighbor to the north. They somehow muddle through.

City	Country	Population	Pop/Hectare	Drive	Transit	Walking	Cycling	Other
New York	US	21,199,865	20.5	67.6	24.8	5.7	0.3	1.6
Toronto	CA	5,113,149	27.2	71.1	22.2	4.8	1	0.9
Montreal	CA	3,635,571	19.8	70.4	21.4	5.7	1.6	0.9
Sydney	AU	4,119,189	20.4	71.2	21.2	4.9	0.7	2
Ottawa	CA	846,802	17.2	68.1	21.2	7.6	2.2	0.9
Vancouver	CA	2,116,581	17.2	74.4	16.5	6.3	1.7	1.1
Calgary	CA	1,079,310	14	76.6	15.6	5.4	1.3	1
Melbourne	AU	3,592,592	15.7	79.3	13.9	3.6	1.3	1.9
Winnipeg	CA	694,668	14.3	78.7	13	5.8	1.6	0.9
Chicago	US	9,157,540	15.1	83.9	11.5	3.2	0.3	1
Perth	AU	1,445,073	12.1	83.3	10.4	2.7	1.2	2.4
Victoria	CA	330,088	11.1	71.7	10.2	10.4	5.7	2
Adelaide	AU	1,105,839	13.8	83.1	9.9	3.2	1.5	2.3
San Francisco	US	4,123,740	27	84.2	9.7	3.4	1.1	1.4
Edmonton	CA	1,034,945	10.1	82.8	9.7	5.1	1.1	1.2
Washington DC	US	4,923,153	13.1	86.5	9.4	3	0.3	1
Philadelphia	US	6,188,463	11	86.1	8.8	4	0.3	0.8
Canberra	AU	368,129	10.8	82	7.9	4.9	2.5	2.7
Seattle	US	3,554,760	10.9	87.7	7	3.3	0.6	1.4
Hobart	AU	200,524	10.3	82.6	6.4	7.6	1.1	2.3
Portland	US	2,265,223	12.9	89.4	6	3.1	0.8	0.7
New Orleans	US	1,337,726	19.7	89.3	5.4	2.7	0.6	1.4
Los Angeles	US	16,373,645	27.3	91.1	4.7	2.7	0.6	1.1
Minneapolis	US	2,968,806	10.3	91.8	4.5	2.5	0.4	0.6
Denver	US	2,581,506	15.4	91.4	4.4	2.5	0.7	0.8
Las Vegas	US	1,563,282	17.7	91.2	4.1	2.4	0.5	1.4
Milwaukee	US	1,689,572	10.4	92.7	4	2.8	0.2	0.6
Miami	US	3,876,380	17	92.7	3.9	1.8	0.5	1.1
San Diego	US	2,813,833	13.2	91.2	3.4	3.5	0.6	1.4
Cleveland	US	2,495,831	10.7	93.7	3.4	2.1	0.2	0.6
Houston	US	4,669,571	11.4	93.9	3.3	1.6	0.3	1.1
San Antonio	US	1,592,383	12.6	93.6	2.8	2.4	0.1	1.2
Sacramento	US	1,796,857	14.6	92.3	2.7	2.3	1.4	1
Columbus	US	1,540,157	11	94.3	2.2	2.5	0.2	0.5
Phoenix	US	3,251,876	14	93.4	1.9	2.1	0.9	1.4
Detroit	US	5,456,428	11.9	95.3	1.7	1.8	0.2	0.5
Dallas	US	5,221,801	11.3	95.5	1.7	1.5	0.1	1

Table 17.1: Density and Travel Mode to Work, US, [Australian](#) and [Canadian](#) Cities 2000-2006. Source: (Mees 2009).

Figure 17.4: Ribbon Cutting of Metro Transit Green Line in 2014. Source: Metropolitan Council.



17.4 *Transit federalism*

Since transit benefits local areas, it should be primarily locally funded and managed. Federal funding for transit has distorted investment to be capital intensive – favoring ribbon cuttings for politicians (e.g. Figure 17.4) – while resulting in neglect for local operations. While the rational local transit organization will take advantage of federal largesse, there is no good reason for federal involvement. Over the next few transport legislative cycles, it is quite possible that federal grant programs (funding) will be transformed into loans (financing). Mass transit utilities would be better adapted to this new environment.

It is not at all obvious that what the federal government’s actual policy under the long-standing transit policy regime since the 1970s (giving politicians ribbon cuttings) effectively helps poor people reach destinations.

Urban scholar Lisa Schweitzer, while acknowledging “walking, biking, and transit advocates have overstated their claims to global benefits in trying to make a case for their slice of federal dollars,” writes in favor of federal demonstration grants:²⁶

²⁶ (Schweitzer 2014c).

The real pain comes in thinking about those places that don’t have deep pockets. Without difficult-to-justify federal capital subsidies, there is no Portland as it exists now, and while I die inside every time one of my starry-eyed students/philosopher-kings advocates for yet another slow light rail in Los Angeles “because Portland!”, federal subsidies have given the US truly important social experiments with transit, given how the feds shoveled out for BART, Portland, and DC’s metro. Nope it wasn’t particularly just or rational, but it sure has been interesting and transformative, and for the better. In concert with transit experiments in Europe, Asia, and South America, it’s mattered a lot to urban scholarship.

The problem is opportunity cost. Portlanders, we believe, could have made Portland into today’s *Portlandia* without the federal subsidies, that is, all by themselves, had they wanted to, if they truly believed in what they were doing. Not that we fault them for

asking for federal money, we just fault the US for giving it to them.²⁷ What did we not do because we gave money to Portland? If it's fewer buses where that would have been valuable, or less food for the poor, or fewer large screen TVs for the taxpayer is an ethical question of what you do with the money, but by spending money on LRT in Portland, something else was not done. But, you want to fund one instance of one new technology for Science!, okay, but you only get one. Science too has diminishing returns, the Morgantown PRT for instance.²⁸

Even if there were a better way for cities to be, and certainly there is, there is no evidence that the federal government knows this better than locals. We don't have a problem with federal financing, as long as the loans are paid back, with interest, by the revenue from the project (or ancillary spillovers like adjacent development). But we fail to see any reason for the federal government to systematically fund capital intensive, low return-on-investment, local benefitting investments.

As we argue earlier subsidizing demand on equity grounds more directly serves the persons in need, is more efficient in the resulting allocation of resources, and allows consumers maximum choice. The resulting investment outcomes would be quite different. This is the [spatial equity question](#),²⁹ Undoubtedly some places are poorer than others. But why should the jurisdiction be subsidized rather than the poor residents. It makes more sense to give grants to poor people in Mississippi than to jurisdictions in Mississippi that happen to have poor people, or build new infrastructure that no one has money to maintain or operate. This would be demand-side rather than supply-side support, but that will lead to better transport for the people as a whole, not just the lucky ones served by one local expensive project, and fewer ribbon cuttings for their elected officials.

²⁷ Just as we don't fault the person making the bribe – they're doing their job, just the person taking it – they're not.

²⁸ A demonstration automated personal rapid transit system on the Morgantown campus of West Virginia University.

²⁹ §4.5.

17.5 *Whose values?*

One lens through which to view transport policy is that of values. Should policy favor driving or transit? How much should we care about safety, and what should we do about it? How should we pay for infrastructure, maintenance and operations? What about the environment? These are some questions that arise in transport policy, and how we answer them reflects values held by someone. Does transport policy reflect what the public wants? While devolving power from the federal government to the states may result in policies that better align with local preferences, one can take further steps, not just devolving from states to local

governments, but from representative government directly to the people.

At the heart of this question is representation. How are the public's values represented thorough policy? There are two ways:

1. There are appointed officials who run planning organizations that make policy decisions, and
2. Voters are asked to vote directly on specific policies, such as new taxes or particular projects.

In the context of appointed officials, generally speaking they will act as a proxy for the values of the elected officials who appointed them, and should favor policies that the officials campaign on. This could be street maintenance, new rail systems, better bus service, bike lanes, etc. They do, however, have a great deal of autonomy, and the daily management of transport systems, rather than splashy new investments, will be shaped by the values of the managers. Because of this, it matters that many of the political appointees that oversee transport decisions do not reflect the public at large.

There are no federal requirements for MPO board structures, and these structures vary substantially across the nation. Some MPO boards are balanced between 'urban' and 'suburban' interests, but most are not. In a 1994 study, researchers showed that for MPOs with central cities that had more than 200,000 residents, over 90% of the central cities were underrepresented on the board.³⁰ In a 2003 study, the effects of geographic imbalance were estimated and the authors found that, unsurprisingly, for each additional suburban representative on the MPO board there was a shift in spending away from transit toward roads.³¹ The urban-suburban distribution is but one source of bias in MPO representation. Board make up rarely matches the racial and ethnic distributions within a regional population. On average, MPO boards were found to be 88% white when the regional average was 61 percent. Racial and ethnic minorities were substantially underrepresented.³²

An issue with these representation characteristics is that MPO priorities will be more likely to reflect the values of a white, suburban resident, who, in turn, is statistically more likely to be a driver and less likely to be a transit user. Thus, the many small decisions and priorities tend to favor suburban drivers even if there are a few large investments in a flashy transit line.

In a different bias, MPO headquarters will tend to be in Central Business Districts, so though fewer than 15% of regional workers work downtown, the suburb to CBD commute will get disproportionate attention from MPO staff and leadership; and

³⁰ (Benjamin et al. 1994). It would be useful for this to be updated.

³¹ (Nelson et al. 2004).

³² (Sanchez 2006).

transit investments will tend to favor that movement despite it being a smaller and smaller share of total travel.

An alternative to appointed representatives is to move toward direct democracy, where voters express support of, or opposition to, projects or policies through ballot box initiatives. Putting the decision directly to the voters is gaining in popularity as local financial commitments is gaining importance as the federal contribution shrinks.³³ Ballot box initiatives must be broadly popular to garner enough votes to pass (in some cases, such as California, with a supermajority). Generally, this holds as over 70% of transport initiatives are passed. But do these ballot initiatives represent voter values?

³³ (Goldman and Wachs 2003).

In many ways transport referenda do represent voter values because to get them passed everybody gets something promised to them. Successful initiatives are those that feature multimodal investment spread throughout the region.³⁴ Yet ensuring geographic equity can come at the expense of good planning.

³⁴ (Werbel and Haas 2002).

One reason that popular votes are a poor judge of the quality of projects is that the public often has a hard time understanding the issues. The best example of this is the perennial complaints about congestion, which have topped commuter concerns for decades. While commuters complain about congestion, they have little appetite for the medicine that will cure it, which, as we and most transport economists argue, is [congestion pricing](#).³⁵ Commuters do, however, have insatiable appetite for all kinds of promises that are intuitively appealing but ineffectual at minimizing delay. Building more road lanes [does not reduce congestion](#),³⁶ which Anthony Downs wrote about in the early 1960s³⁷ and we have been [relearning](#);³⁸ ever since. But drivers like hearing that building more roads will work, so they are willing to vote for it. Transit expansion is another example.

³⁵ §6.

³⁶ §14.

³⁷ (Downs 1962).

³⁸ §14.3.

Voters overwhelmingly approve transit projects when asked to vote on them. Yet the support for transit spending, even when accompanied by new taxes, far outpaces actual transit ridership. Over half of all Americans have *never* even used transit, yet transit referenda regularly pass with large majorities. This suggests that far more people desire transit spending than desire transit usage. Michael Manville and Benjamin Cummins looked at this puzzle and concluded that transit support is most aligned with concerns about the environment or congestion.³⁹ In short, people largely favor transit at the ballot box so that someone else can use it.

³⁹ (Manville and Cummins 2015).

So, MPOs are managed by people who don't reflect the diversity of the region, and most often see the world through a windshield.

This results in auto-oriented planning and investment that is tilted toward suburban circumstances. Appealing to direct democracy causes problems as well, as voters often don't know the full details about what they are voting on. There is a mismatch between what the public values and what is provided. Absent a benevolent dictator, it may seem unsolvable, but there are some good ideas. We should start with a requirement that the people in charge of our transport systems are *users*,⁴⁰ of the systems.

⁴⁰ §17.6.

17.6 'Dogfooding': Ensure managers use the system

Employees, and management, and directors or council-members of transit agencies should ride transit to work and other activities.⁴¹

⁴¹ Similarly employees (including senior management) of highway agencies should use roads to get to work, though this undoubtedly occurs naturally for the vast majority of even 'multi-modal' departments of transport or highway agency employees, and doesn't require further discussion.

The term 'dogfooding,' derived from 'eating your own dog food,' is popular in the tech sector, and implies that a company should use its own products wherever it can. Thus, in general, Apple employees should have Macs on their desks rather than Windows machines, and Google employees should use Gmail. The advantages of this are several. Most importantly, bugs can be efficiently identified by employees using the system on a daily basis, and feedback can be channeled quickly through the organization. Secondarily, missing features can be quickly identified similarly. Employees will get better empathy for the experience of paying customers.

There are limits to this process. You would not expect Boeing Defense employees to take a helicopter home with them, or even operate one on a regular basis. However, for most consumer products companies, this is a highly useful practice.

On a transport network, no-one can systematically use the entire system, everyone is spatially constrained in where they travel. Further, the bus drivers on the first ride of the morning (or the last in the evening) cannot practically ride transit to work in a system that does not operate 24/7, since there is no bus to get the bus driver there, or take her home.

Still, there are many opportunities for many employees, and more importantly, directors and Board members, of transit agencies to use transit, and increasing this number would improve service. Generally, transit administrators don't ride enough. Consider these headlines:

- Washington DC: Washington Post survey of the WMATA Board found "Few ride the bus regularly." (Though they do get a free pass).⁴²
- San Francisco region:

⁴² (Wilson Andrews and Lazo 2013).

- Dorothy Dugger general manager of BART drives to work (2007): BART appoints first female general manager.⁴³
- Time to tie pay to Muni's on-time performance.⁴⁴

⁴³ (Bay City News Service 2007).

⁴⁴ (Golinger 2014).

"In 1993, a grass-roots citizens group founded by [former and future Governor Jerry] Brown collected thousands of petition signatures and put a measure on the San Francisco ballot requiring the mayor, supervisors, and top city officials to ride Muni or other public transit to work at least twice every week. In the voter information pamphlet, Brown wrote: "Government is getting out of touch because too many officeholders and city workers act like potentates, not public servants. Send them a message! VOTE YES on AA to get them back to reality by riding the Muni twice a week." San Francisco voters overwhelmingly agreed, with 65% voting to make this official city policy. So when was the last time you saw Mayor Ed Lee on your Muni bus?"

- Houston, Texas: Metro execs to drive less, ride transit more.⁴⁵

⁴⁵ (Snyder 2010).

About a dozen of the Metropolitan Transit Authority's senior managers will be required to ride public transit 40 times per month, and some will be giving up their staff cars or car allowances. "I know of no business where you can be successful without using your own product and believing in it," George Greanias, Metro's president and chief executive officer, said after announcing the changes during a public hearing today on the agency's 2011 budget. Frequent use of buses or light rail will give Metro executives a better understanding of what the agency's customers experience, Greanias said, while sending a message that Metro is committed to public transport. Perhaps not coincidentally Houston subsequently redesigned its network, and is one of the few US agencies not to lose ridership in 2016.

⁴⁶ (Davidson 2014).

- Salt Lake City, Utah: Just three of 16 UTA trustees accepted a challenge to use bus and rail exclusively for seven days.⁴⁶ One of those who accepted, Keith Bartholomew, is a faculty member at the University of Utah.
- Minneapolis - St. Paul, Minnesota:⁴⁷ David Levinson is quoted as saying:^{48,49}

⁴⁷ Following an earlier version of this chapter's original posting on the Transportist blog, Eric Roper wrote an article on this topic about Minnesota's MetroTransit. Commentary includes: (Magrino 2014b; Norvell 2014).

⁴⁸ (Roper 2014).

⁴⁹ Subsequently Susan Haigh, who claimed in a related article (Roper et al. 2014) that she was too busy to use the convenient Green Line Light Rail Transit between her day job at Habitat for Humanity and her part-time role as the Chair of the Met Council stepped down from the position (Lindberg and Melo 2015). The bad publicity from this article did not help. Brian Lamb, the Head of Metro Transit, called to complain to administrators at the University of Minnesota about David Levinson. They passed on the complaint, but of course defended free speech, as they should.

"We should ask whether members of the council have sufficient expertise about transit ... to be managing a transit system. Do they understand the problems at a deep level? We can compare the low transit usage by the Met Council to the board of Apple not using their own computers. Having that experience of being lost on the transit system is probably a useful experience for [council members] to have to understand why their system isn't as attractive as it should be, why it's not as popular as they hope it would be."

That said, the opposite problem, free travel passes for transit administrators, (and especially free travel passes for family members) are also controversial, as noted in these two articles:

⁵⁰ (Neuman 2008).

⁵¹ (Bay Area News Group 2014).

- New York City: M.T.A. Revokes Travel Perks for Board Members, from 2008 but with this gem “Why should I ride and inconvenience myself when I can ride in a car?”⁵⁰
- BART’s Board also gets a free pass for life, for their families too.⁵¹

It is not clear to us why an unused pass should be a problem, it costs no one anything except in an accounting sense. A free pass for an unpaid or underpaid transit Board who ought to be checking up on the system like mystery shoppers seems the least of worries. We can see how giving passes to family members stinks of favoritism though.

This problem appears outside the US.

⁵² (Transport Blog (Matt L) 2014).

- Auckland, New Zealand: local transport agency’s staff shuttle connects between offices, rather than having staff use public transport, which is a bit slower.⁵²

“Staff at the agency which runs public transport in Auckland are being offered a shuttle service for business trips between offices, because buses and trains are too slow. Auckland Transport (AT) is spending more than \$122,000 over six months, trialling the shuttle between its downtown offices and its headquarters in Henderson. Public transport advocates say staff travelling between the Henderson and downtown locations should be using the bus and rail services at the door of both offices. AT wants to reduce its car fleet by 20 vehicles, and is encouraging staff to cut car use. “We’re providing options for staff, to have a tele-conference, to catch public transport using business AT HOP cards, and we’re also providing a shuttle between Henderson and Britomart,” AT community transport manager Matthew Rednall said.”

17.7 *Should voters have full information when voting on transport projects?*

Voters are asked to vote on all kinds of transport projects. In part this is because of declining federal support for projects, and local tax increases require voter approval. Elected officials hesitate to promote new taxes to fund projects without clear direction from the electorate. New taxes for transport spending usually pass. Yet there are many referenda on specific projects where taxes are proposed for a particular investment. Without making any claims about the value of any of the individual projects, it is worth considering when

projects violate the spirit and letter of the votes taken. California's high-speed rail has also been criticized for not adhering to the specific systems and costs spelled out in the statewide 2008 referendum to raise a share of the cost of the project.

This isn't just a problem for transit projects, either, though maybe it is a problem that is worse in California because of a variety of populist legislative requirements. Here is another Golden State example. The *LA Times* reports that the 405 toll road project got into political trouble:⁵³ There are a few causes described:

⁵³ (Esquivel and Flores 2013).

At a meeting this month, crowds packed an Orange County Transportation Authority board meeting to denounce the lanes, which have been supported by Caltrans. City leaders expressed worry that the project would push traffic onto their streets, or that motorists traveling in the toll lanes would find it too difficult to pull off the highway and patronize local businesses.

The political shift over toll lanes has several causes. Some of Orange County's toll roads have struggled to attract drivers and each of the major corridors has been forced to refinance its debt to avoid possible default.

There has also been the sticker shock: Riding the 91 Express Lanes can cost nearly \$10 each way at the most congested hours, an investment even for Lexus drivers. If the 405 toll lanes are built, the priciest one-way toll would cost \$9.91.

As for the 405, much of the anger stems from what Orange County Supervisor John Moorlach called a "bit of a bait and switch."⁵⁴ When voters approved a countywide half-cent sales tax, they were told funds would go toward adding one general purpose lane in each direction at a cost of \$1.25 billion.

⁵⁴ (Esquivel and Flores 2013).

Instead, the proposal before the OCTA would add one free lane and one toll lane in each direction – but it would also convert an existing carpool lane in each direction into a second toll lane, with the added \$220 million price tag paid through bond sales that in turn would be paid off by tolls.

So, the project as implemented is not what the voters approved. It is substantially different, in fact. Is this direct democracy or something more sinister? Voters often oppose new taxes or fees because they don't believe the revenues will be used as promised. The votes for specific projects are not held as binding. This introduces credible commitment problems that may affect future votes.

There are many problems associated with these types of direct democracy for allocating scarce resources. When voters vote on a project, be it rail, transit, roads, etc., they should have complete information. Since transport infrastructure projects tend to go over

budget frequently, which affects the scope of the projects, it is difficult for voters to accurately assess their support or opposition. Also problematic is the absence of recourse the voters have. By pushing tax and spending decisions to the ballot box, elected officials insulate themselves from the severe problems that tend to arise. After all, it was the voters who approved the project, not Representative So and So from the great state of Denial.

17.8 Coordinate local transport and land use policies

Local transport policy should be coordinated with local land use policies to improve accessibility by all modes of transport.

The governance issues ought not be underestimated. The United States has many distinct layers of government: homeowners associations, cities, counties, metros, state, federal, all of which have a greater or lesser say in particular decisions. Coordination will always be a challenge. Reducing the relevant layers of government through municipal and regional consolidation should certainly be considered if possible. Metropolitan areas have developed different levels of coordination, with some (e.g. Portland, Oregon) developing a relatively strong metropolitan level government, and others (e.g. Washington, DC) remaining weak (in large part due to the interstate nature of government there).

A second difficulty is that any change to policy creates winners and losers. It is often implicitly assumed the status quo is equitable, though there is generally no evidence to support that. The current mix of funding sources benefits some parties more than others: the benefits and costs do not necessarily align, some jurisdictions cross-subsidize others; and the poor generally pay a greater share of their income on transport than the rich. Developing a system that would be universally acclaimed as fair is probably impossible, however developing a system that improves equity compared to the system today is feasible.

The federal government's recent initiatives on livability provide an opening to catalyze better transport and land use coordination. Grants could be made available for demonstration programs in transport-land use coordination, much like the Urban Partnership Agreements in President George W. Bush's Administration. Ultimately however these demonstrations would need to show real benefits, we cannot rely on federal grants to encourage local governments to do something that should be in their own collective interest. If such coordination does add value, as suggested here, it will make those regions more competitive, and can drive a race to

the top as other communities try to emulate their governance to achieve similar positive outcomes.

17.9 *Department of Accessibility*

The problem is that as our society has become more complex, we often find ourselves using a variety of means to achieve a single set of goals. We are interested, for example, in economic development which requires new markets, more productive workers and better transportation systems. But which department do we go to for that? And what if we want to build a new city, with sufficient public facilities, adequate housing, and decent recreation area – Which department do we petition then?

We sometimes seem to have forgotten that government is not in business to deal with subjects on a chart but to achieve real objectives for real human beings. These objectives will never be fully achieved unless we change our old ways of thinking. It is not enough merely to reshuffle departments for the sake of reshuffling them. We must rebuild the executive branch according to a new understanding of how government can best be organized to perform effectively.

The key to that new understanding is the concept that the executive branch of the government should be organized around basic goals. Instead of grouping activities by narrow subjects or by limited constituencies, we should organize them around the great purposes of government in modern society. For only when a department is set up to achieve a given set of purposes, can we effectively hold that department accountable for achieving them. Only when the responsibility for realizing basic objectives is clearly focused in a specific governmental unit, can we reasonably hope that those objectives will be realized.

– Richard Nixon, Message to Congress, March 25, 1971⁵⁵

⁵⁵ House Document 92-75.

The opening quote describes how and why President Nixon proposed a major reorganization of the US federal government, including a Department of Community Development that would consolidate most of the then newly created Department of Transportation with Housing and Urban Development in order to “to help build a wholesome and safe community for environment for every American.”⁵⁶ This bill never made it to the floor of the House of Representatives. That doesn’t mean the idea doesn’t have merit though.

Urbanist Richard Florida has proposed a US Department of Cities, which echoes this Nixonian idea to some extent.⁵⁷ It would have a similar footprint, Florida writes:⁵⁸

The new Department of Cities would absorb pieces of HUD and the Departments of Energy, Transportation, Education, Commerce and Interior. Rather than bloating the federal bureaucracy, it would make

⁵⁶ Discussed by (Davis 2018).

⁵⁷ (Florida 2013).

⁵⁸ America didn’t get urban renewal right the first time, so let’s try again, but with even more authority. Florida became an ardent federalist after the election of Donald Trump and now argues that cities and states need more power. We do not think our favored policies should depend on who is in power. (Inskeep 2017).

it leaner, by directing federal investments strategically to the places where they can provide the most bang for the buck. With a simple mission of catalyzing and accelerating intelligent urban reforms, it could be the first department to embrace and act on the new mantra of more effective government: “cut to invest.”

Streets.mn writer and sustainability planner Brendon Slotterback has called for a state Department of Accessibility,⁵⁹ writing:

What if instead of a [state] Department of Transportation [(DOT)] we had a Department of Accessibility and its mission was to improve accessibility while meeting environmental standards, building resilient systems, and being economically viable? I bet it would look at lot different than our current DOTs (hint: it would do a lot more with land use).

These proposals address the mismatch between the functional scope of government agencies (indicated by colors on [Figure 17.1](#)) and the scope of problems they seek to address. Increasing accessibility, as we [note earlier](#),⁶⁰ requires not only transport solutions (making the network more direct and faster), but also land use solutions (co-locating jobs and workers or consumers and retailers or retailers and wholesalers, etc.) in close proximity so the distance, and thus the time, required to engage in interactions diminishes. While transport agencies deal with the transport aspects, land use agencies deal with the land use aspects. The land use planners complain they can’t control transport, and so are responding to the conditions given, which is to permit development [induced](#)⁶¹ by the new access that roads create. Transport planners assert they do not regulate or develop land use, and so are building roads responding to the market environment which says there is demand in excess of supply from existing developments. Both are correct in their way.

The consequence is the landscape before us which is laden with inefficiencies and spatial-network mismatches. If only there were a single department regulating both. The difficulties in this are political, and in particular have to do with the different layers of government. Land use is generally treated as a local decision, and transport as a regional decision. Readers of this book will likely agree the scope of transport investments are often regional (metropolitan) in the modern world. Towns cannot effectively build highways or metros; local governments, and their residents are loathe to abandon their powers over land use to a higher level government, fearing that they will get saddled with locally unwanted land uses, such as garbage transfer stations or high density housing. And these are a problem because they generate

⁵⁹ (Slotterback 2013).

⁶⁰ §1.

⁶¹ §14.

externalities,⁶² like pollution,⁶³ and congestion,⁶⁴ and other impacts like school crowding, that are uncompensated because of failure to properly finance capital facilities and charge for them. Local residents correctly perceive a degradation in the quality of their life for the benefit of others.

The Metropolitan Council of the Twin Cities has some aspects of a Department of Accessibility. It implements long run plans for the seven county region in Minnesota,⁶⁵ ensures that county and municipal land use plans comply with the region's long range plans,⁶⁶ approves the deployment of transport facilities, and operates the public transit agency, among other functions. But it does not approve or reject specific development. It cannot force growth into a municipality that resists, though it can slow growth by denying water and wastewater service, limiting density, nor can it generate growth the market does not want to produce.

While we are not going to argue that the current bureaucratic organization chart is somehow optimal, we are also skeptical that reorganizing necessarily solves problems. There are reasons for the current arrangements, and while these arrangements might be suboptimal in producing accessibility, they may result in more local input on land use decisions which could improve outcomes. At this time, there is no evidence one way or another that a larger or smaller level of government in charge of land use, or consolidating land use and transport decision-making into a single Department, produces more or less accessibility. This suggests that experiments are in order.

17.10 *Metropolitan Department for Transport*

Since transportation and land uses are co-dependent, it makes sense to coordinate these planning and policy activities. But as described above, this is difficult in practice. Perhaps we should have a Metropolitan, rather than state level, Department for Transport that controls all of the transport systems within urban areas.

Currently, highways are paid and planned separately from transit, which is separate from local roads, which is separate from cycling, and so on. Even worse is that no one responsible for transport systems has much of anything to do with parking requirements. Niskanen's model of bureaucracy⁶⁷ predicts that each independent bureaucracy supplying transport will work to maximize its own budget. We see this is the case – departments charged with road building want more money to build more roads and transit agencies want more money to supply more transit. But

⁶² §7.

⁶³ §8.

⁶⁴ §5.

⁶⁵ Hennepin, Ramsey, Washington, Scott, Dakota, Anoka, Carver.

⁶⁶ This authority was confirmed in a court case Supreme Court of Minnesota. The City of Lake Elmo, Appellant, v. Metropolitan Council, Respondent. No.:A03-458. Decided: August 05, 2004. (Supreme Court of Minnesota 2004).

⁶⁷ (Niskanen 1971).

no one is trying to maximize accessibility, only their individual mandate.

A model to emulate is one where a single department must make internal trade-offs about what to supply and where. If we keep expanding the road network and keep driving cheap there is no amount of new transit supply that will make a meaningful positive change in transit ridership. Bureaucratic competition among modes must stop.

A close approximation to how this could work is the Transport for London (TfL) integrated model. Created in 2000, TfL is under mayoral control, and is responsible for all roads, subway, commuter and light rail, buses, taxis, cycling and river services. In short, everything except National Rail, and they are acquiring pieces of that as well. They also administer London's congestion charge. In 2004, London implemented parking maximums, as well, limiting how much new parking could be built.

Other than the iconic Underground, TfL acts as a coordinator rather than operator.⁶⁸ Most services, and all buses, are operated through a concession system. What TfL is able to do through this role is to minimize expansionary tendencies by all transport suppliers and maximize overall accessibility. Being under mayoral control puts this coordinated transport governance closer to land use decision making, as well. So even if a Department of Accessibility is a long reach, an integrated Metropolitan Department for Transport might well be a feasible and successful first step.

⁶⁸ Offloading the Underground was an unsuccessful experiment in Public-Private Partnerships (Wolmar 2002).

17.11 *The lump of government mistake*

⁶⁹ Not including the 35-day 2018-19 shutdown that occurred as we wrote this.

From 1976 through 2017,⁶⁹ the US federal government was without a budget for a total of 160 days, nearly half a year in 42 years, or just over 2% of the time. Of those days, it was shut down for 61 days (when many, sometimes referred to as 'non-essential', government workers were furloughed), or two months.⁷⁰ Other solutions are almost as bad. For instance, in 2013 the US federal government implemented a sequester. Most sectors of government were cut by some fixed amount. Much has been written about how stupid this is. The proximate cause is the immediate stupidity of politicians trying to create a Sword of Damocles above their colleagues to get them to do something less stupid. There is a root cause. This is what we call the 'Lump of Government Mistake.'

⁷⁰ (Wikipedia contributors 2018f).

Almost all agencies of the federal government are on the general budget, paid for from general revenue, with an annual appropriate cycle. This need not be the case. We could instead have many

separate agencies, each with their own user-based revenue sources, for as many parts of government as possible.

- Highways already have a Highway Trust Fund (underfunded perhaps, but that is a relatively simple problem if there were an actual desire to govern responsibly). Despite all the dysfunctions we ascribe to US transport policy, this could be a model compared to the dysfunctions elsewhere in government.
- Air Traffic Control could be handled by a private corporation paid for from some kind of user fee on aircraft movements, like it is in Canada or New Zealand.⁷¹
- National Parks could be owned by a Foundation (or better multiple Foundations) that solicit donations and charge cars for the use of parking and roads to cover operating costs.
- Food Inspection Services could be a Non-Profit Corporation paid for by a small tax on food producers (like the Food Marketing Boards) and administered separately.

⁷¹ (Button and McDougall 2006).

We can go on and identify many parts of government that can easily be hived off into separable, self-sustaining, non-profit organizations.

Once we did that, the threat of sequester or government shut down disrupting the obviously generally useful things that happen to be publicly owned in the US makes a lot less sense.

Clearly there are exceptions, true [public goods](#)⁷² like National Defense and Foreign Relations perhaps. Similarly interest (and principal) on the accumulated debt needs to be handled somehow. Everyone receives ‘defense services’ from the Department of Defense (whether you want it or not), so it needs to be paid for from a general revenue source. But this need not be the same general revenue source as used for income redistribution (like Social Security), or health insurance (like Medicaid or Medicare). In fact it is not. Social Security taxes pay for Social Security. Why should not Defense taxes (e.g. a Value Added Tax (VAT)) pay for Defense. Under this scheme, if Congress wants more, it raises the VAT rate associated with Defense, if it wants less, it lowers the rate.

⁷² §A.

The National Science Foundation similarly should not be subject to the vagaries of annual budgets. Like any good foundation, it should have an endowment, and live off the interest.

THE LESSON TO BE LEARNED IS THAT, TO AVOID A TOTAL GOVERNMENT SHUTDOWN, THE GOVERNMENT SHOULD NOT BE TOTALLY CENTRAL. Every function could have its own associated

source of funds and rates, and would stand or fall on its own merits. Horse trading would still exist, but this notion of cutting useful self-sustainable services as collateral damage for reducing the Defense sector (or building a wall on the southern border) would be eliminated. Governance would be more resilient.



Figure 18.1: Sydney L1 LRT is a privately managed rail line.

Once upon a time, roads were solely the responsibility of the adjoining landowners, and we had roads of poor quality – justifying governmental takeover (either directly or through quasi-governmental organization) to impose prices. Like today’s sidewalks, property owners were once responsible for maintaining a right-of-way across their property. But they had little motive to do this well (the analogy with sidewalks remains), and a race-to-the-bottom ensued, where these paths were of poor quality, inconveniencing travelers. As the Good Roads Movements (in various forms through history) demanded higher quality for the benefit of travelers, and landowners had no incentives, government naturally took over.

Today, roads may be the one of the last bastions of socialism in the US. While we may want to temper that claim after the US nationalized the auto industry and some banks during the Crisis of 2008; now that those holdings have been sold off, we are back to highways as the flagship of US socialist enterprise.

Socialism is widely defined as an economic system characterized by social (public, government) ownership of the means of production and management of the economy.

Almost all the roads in the United States are publicly-owned (either by states, counties, or cities or towns). They are allocated first-come, first-serve, without regard to wealth (aside from the entry cost of owning a vehicle), paid for by taxes (some on users, some on land owners, some otherwise). One might almost say “from each according to his abilities, to each according to his needs.”¹

¹ This quote is from Marx’s 1875 *Critique of the Gotha Program*.

A critique of such socialist, (or dare we say it, communist), allocation schemes is that they are inefficient, they allocate resources poorly. Queues are quite common due to undersupply and lack of a real-time price signal, which gas taxes cannot replicate. Clearly we still see congestion on our unpriced roads. Congestion is nothing if not queueing.

However, not all roads have always been socialist, many were initially private turnpikes.

² (Smith 1776).

Adam Smith² believed useful public works would pay for themselves, be ‘self-liquidating’ as financiers say.

The greater part of such public works may easily be so managed as to afford a particular revenue for defraying their own expenses, without bringing any burden upon the general revenue of the society.

But though he favors what we would call user fees (they “afford a particular revenue”), Smith warns against private, unregulated toll roads:

The tolls for the maintenance of a high road cannot with any safety be made the property of private persons.

The reason is the monopoly power of roads, users have few good choices, so the “private persons” who might own such a road will exploit it by charging excessive tolls, benefiting the road owners at the expense of the road users, and the wealthy at the expense of the poor.

Smith was correct in principle, but turnpikes in the US were largely unprofitable through the 19th century. There are even a handful of private highways in the US today (and far more in other countries). Other places have non-profit but non-government

private road associations. Even nominally socially-democratic Sweden has two-thirds of its road network managed this way.³

³ (Malmberg and Ivarsson 2006).

But efforts at building new private roads are highly constrained. For one, these private roads are competing against subsidized ('free') public roads, limiting their pricing powers. Second, the public has an exclusive monopoly on the power of eminent domain, enabling it to build roads without the hold-up problem that a private entrepreneur trying to fashion a means of production through the fields of others might face. Yet even opportunities that might suggest a perfect opportunity, for instance a bridge between two states with little nearby competition, is built by the government because there clearly is insufficient benefit to attract a private firm. Third, private roads are subject to taxes, while public roads are tax-free.⁴

Should roads be socialist? If they are socialist, what government should govern?

⁴ Now wipe away those tears, put away that tiny violin playing that small sad song, we come not to weep for poor capitalists.

Though in politics, words like communist, socialist, and capitalist are thrown around as pejoratives, when we actually decide whether a sector is public or private, it is usually based on history, a set of contingent events that could have played out differently. In the US, transit was private, now it is public. Railroads are private. In the UK, bus transit was private, then was public, and again is privately provided (under public franchise agreement), but railway track (to a first-order approximation, the legalities are complex) is public. There is no universal principal of how much government is right.⁵ As Hans Rosling said:

⁵ Unless you are a Marxist or an anarcho-capitalist.

People who don't like government, go into this corner and discuss Somalia, People who don't like markets, go into that corner and discuss North Korea.⁶

⁶ Quote from Hans Rosling presentation at Ted Mann Theater, Minneapolis. April 27, 2011.

Pragmatics decide. Many things are clearly better in the private sector, we are collectively (if not unanimously) confident the government could not provide the same quality good for the price. Other things are clearly better in the public sector, since the private sector cannot provide the good as universally as we desire for technical reasons (free rider problems for instance). We have multiple goals, efficiency is among them, though equity is also be important. Reasonable people will disagree about the relative importance of each.

Roads may fall under any of the classic four categories of *goods*:⁷ congesting,⁸ club, public, or private, depending on their characteristics. Even if they are 'public,' which 'public' becomes a question, as there are multiple layers of government, and as the Swedes show, one can easily create new special layers of

⁷ §A.

⁸ These are often called 'common pool resources' in the economics literature.

government for the purpose of managing roads, which have spatially distinct sets of users.

Against this differing nature of roads falls the idea that there must be some economies of scale in managing roads (even if there isn't much at the margins). Clearly everyone maintaining the road in front of their own home would be costlier than some centralization (a homeowners association, a town), since not everyone has specialized tools to do proper maintenance, and has little incentive to monitor. So even if in the absence of these economies, there would be an argument for different owners, with the economies, we may sacrifice some type of efficiency for another.

A feature (or bug) of socialized roads is the lack of pricing. This of course is not required, but far more likely, as socialized roads are subject to more political interference than a different governance structure.

The auto-highway system is mature, it is on the cusp of decline. Many declining sectors demand (and get) public subsidies they may not have needed during growth. In the US, roads have been getting subsidies for most of their history.⁹ But this is also an opportunity to experiment, to find different models for managing the system (since there is little controversy about maintaining the existing network, while there is great controversy about building new roads, which we seem not to be doing much of any more).

There is not only one possible model, transport is a big sector, and what is public and what is private is fluid.

If we cannot fully decentralize roads to the point where people provide their own, and if we recognize they are not well-structured as a commons, perhaps we can privatize them in such a way that they are competitive, so travelers have some market choice in which roads they use. Theoretically, this has a lot of potential in providing differentiated levels of service.

18.1 *Ownership and network size*

We explore the case for [subsidy](#)¹⁰ for roads and transit elsewhere, discussing the pros and cons of capital and operating subsidy. Yet our discussion has largely focused on individual facilities or projects, or who receives the subsidies. In this section we work through how the physical structure of road networks varies under public or private ownership regimes.

If the street network were limited to one road, it would be very easy to supply privately and finance through tolls, see the Ambassador Bridge in Detroit as an example. For a variety of

⁹ Clearly user fees such as gas taxes could easily be adjusted to avoid this, the evidence is the range of motor fuel taxes globally.

¹⁰ §4.

reasons, it is in fact a network and not just a link. This provides a wealth of benefits, as well as complexity.

Ubiquitous networks have positive returns to scale,¹¹ in that the larger the network, the more valuable it is, as you can reach more destinations. Think of telephones (not very valuable if they are simply tin cans connecting you to a neighbor), transit (not very valuable if it only runs a single route), or airports (you would have to wait a long time if you only had direct connections, not hubs). The problem is that building ubiquitous networks requires large up-front capital expenditures and a base beyond existing users. For instance, while the Interstate Highway System was built by ‘user fees,’ before the first mile of concrete opened, drivers (who obviously had not used the Interstate) were assessed federal motor fuel taxes on all miles traveled, not just Interstate miles. The class of drivers as a whole paid for the Interstate as a whole, and ultimately benefitted as a whole. Any individual traveler may or may not have seen those benefits, or paid for them.¹²

THE PUBLIC WILL OVER-INVEST IN NETWORK SIZE RELATIVE TO THE SOCIAL OPTIMUM AND THE PRIVATE SECTOR WILL UNDER-INVEST RELATIVE TO OPTIMUM. This idea is generally true, though it gets very complicated.

However, private actors will expand their networks in response to demand where the public expands networks for other, and often speculative, reasons. (There are obviously exceptions.)

Consider again the US Interstate Highway System. This network is extremely large,¹³ and is overbuilt in many areas both rural and urban. Unlike most European limited-access motorways, the US Interstate was built by destroying parts of central cities and inner ring suburbs.¹⁴ While these urban freeways are well used, in retrospect they represent an unnecessary expansion of the Interstate system and were built because of generous 90 cents per dollar of subsidy by the federal government (from federal gas taxes paid by motorists into the Highway Trust Fund). While some of the Interstate network is congested, much of the available capacity sits idle for most of the day.¹⁵

Ownership of developing networks also leads to network design that promotes goals other than transport. With contemporary public infrastructure, political goals are often a primary justification. Construction jobs, for instance, are politically popular but are a project cost, not a benefit. Yet public officials support new construction because of the jobs promised. These political goals risk making the costs of the project exceed any benefits. (There is a

¹¹ ‘Ubiquity’ is not necessary for positive returns, but some minimum scale often is.

¹² Similarly, airlines and airports must invest in capital (planes and gates and runways and so on) before it begins to be paid back. The difference is that airlines have investors who see the returns, rather than charging future customers.

¹³ Almost 47,000 *mi* or over 75,000 *km*.

¹⁴ The case of the construction of St. Paul’s I-94 through the Rondo has been made nationally famous by Alan Altshuler. (Altshuler 1966).

¹⁵ It should be noted that President Eisenhower did not expect that the highway system that bears his name would be built in existing cities. He discovered this was the case when construction started in Washington, DC and slowed his trips to Camp David (Swift 2011) p.247.

¹⁶ §10.

macro-economic¹⁶ argument that these jobs benefit the economy as a whole in a period of under-employment in the road construction sector. That is, if the project's laborers would otherwise be unemployed, building something may be better than doing nothing. However if those laborers would otherwise be doing something else more valuable, they are unambiguously a cost.)

Contrast the highways with a largely privately developed network: US broadband. The United States has notoriously slow broadband access, eighteenth in the OECD league tables, and in part this is because we expect that these services should be only provided privately.¹⁷ When a private network provider develops a network they will build a network based on expected profits from usage. This inhibits large capital investments that are purely speculative in nature.¹⁸ Because of this, wise but profit-maximizing broadband suppliers react to market demand by carefully and slowly building out network capacity rather than building lots of network capacity that may be used at some point in the future.

Not all private network constructors are as careful (or profitable) as broadband. History is rife with speculative bubbles in both the railway and internet sectors,¹⁹ while airlines as a whole cumulatively lost more money than they have made.²⁰ However in those bubblicious cases, the race between many competing network providers aimed to establish the monopoly (and gain market share) rather than nourish an existing monopoly, as broadband does.

Broadband networks are also a current example of how monopoly affects network development. Broadband networks are controlled by oligopolies that have little competition in areas where they provide service.²¹ The lack of competition means that these companies need not compete on quality or speed in order to maintain their revenue targets and profits, which helps explain why development of faster services is somewhat sluggish. Within the broadband networks, consumers are not fully realizing lower costs of transporting data online and firms providing the services are ensuring that their networks remain profitable.

¹⁷ See (Smith 2017) for 2017 rankings. There are debates about whether US broadband should be publicly provided, but this seems unlikely as a policy outcome. Australia, which ranks fourth from the bottom on the same table, would kill for US broadband speeds. The dysfunctions in Australia's publicly-driven network deployment are far beyond public vs. private.

¹⁸ Iridium's satellite network is a cautionary tale of this.

¹⁹ (Odlyzko 2010b).

²⁰ (Garrison and Levinson 2014).

²¹ These firms maintain competition across the nation but local markets effectively act as monopolies.

		Degree of Private Role						
		(None) Public Sector	Service Contract	Temporary Private Lease	Franchise Contract	Publicly Developed and Privatized	Privately Developed to remain Private	Privately Developed to be Transferred to Public
Project Stage	Design							
	Build							
	Develop							
	Operate							
	Maintain							

18.2 Public-private partnerships

Figure 18.2: Design, Build, Operate, Maintain.

INSTEAD OF ‘PUBLIC OR PRIVATE’, WE SHOULD THINK ABOUT ‘PRIVATE AND PUBLIC’ – PRIVATE PROVISION OF PUBLIC SERVICES IN TRANSPORT. The term ‘public private partnership’ (sometimes abbreviated to PPP or P3)²² is used today to mean a number of different ways of providing infrastructure. These partnerships may be something as simple as what’s called design-build so that a single firm is responsible for both designing the bridge and building it. Design-build speeds up the construction process and ensures that there’s a single point of responsibility, so you don’t have one company or one agency doing the design and the second doing the construction and then people complain because there’s some miscommunication. Or they may be more elaborate and include design, build, operate, and maintain. The firm that builds the bridge is responsible for operating and maintaining it over a long period of time, and so they don’t build it cheap and then let it fail early. They’re going to pay for the higher costs of higher quality construction if they’re responsible for maintaining it. And presumably that leads to better infrastructure and lower lifetime costs.

²² PPP is a US term, private finance initiative (PFI) is used in the UK.

- Some major types of Public Private Partnerships are:²³
- Build-Own-Operate (BOO): The private business builds and operates a public facility and retains legal ownership
 - Build-Operate-Transfer (BOT): The private business builds and operates the public facility for a significant time period. At the end of the time period, the facility ownership transfers to the public

²³ (United States General Accounting Office 1999).

- Buy-Build-Operate (BBO): The government sells the facility to the private business. The private business refurbishes and operates the facility
- Design-Build-Operate (DBO): A single contract is awarded to a private business which designs, builds, and operates the public facility, but the public retains legal ownership
- Build-Develop-Operate (BDO): The private business buys the public facility, refurbishes it with its own resources, and then operates it through a government contract.

We can think of it as a series of project stages vs. a series of increasingly private roles, as illustrated in [Figure 18.2](#). Contiguous stages can be grouped together as in the list above.

Public private partnerships often feature revenue streams (which is why private firms are interested), which in the case of highways can mean tolls. Yet tolls don't always cover the costs of any given infrastructure project. They do in some cases, but as you can see looking at the United States, most roads are not tolled, most bridges are not tolled. Tolls and user fees (not including gas taxes) are about 8% of US road revenue, varying from 48% in Delaware to 0% in states without tolls.²⁴ And building a single toll bridge might not work from an economic perspective if there are nearby alternatives, but it still may be worthwhile to have the infrastructure. So the state might step in, and instead of paying for the road directly and maintaining it, it pays a firm some amount of money to do this each year. The firm is responsible for maintaining it to a certain performance standard.

The argument in favor of it would be that if the firm is responsible for financing and gets paid back over time, that might help a cash-strapped local government or state government provide infrastructure that it otherwise couldn't provide without borrowing the money. Borrowing is often difficult for local and state governments because of debt limits and the costs of the municipal bond market. On the downside there remains the question of who bears the risk? The negotiation of this is not just negotiation over how much money some firm gets paid, but what happens if the tolls that are expected don't come in? What happens if the demand that's expected on the road doesn't materialize? This is one of the major risks for public private partnerships.

Some projects have gone bankrupt, others are uncompleted. Accountability is an important issue that depends very much on how projects are organized.

²⁴ (Henchman 2014).

LONDON UNDERGROUND. The case of London is instructive, and suggests some of the risks of contracts. The London Underground private finance initiative (PFI) set up was seemingly designed without a clue as to how transport systems work. Christian Wolmer reports legal costs of setting up the contract were £500 million before even operating, we note that still did not deal with the contingency that actually occurred.²⁵ The aim was to rebuild and modernize existing assets, especially before the 2012 Olympics. So as not to interfere with rush hour operations, all construction had to occur between 11:00 pm and 5:00 am, including set-up and break-down, and the system had to be open and operational for the morning commute, or the contractors would face penalties. So the concession-holder spent a couple of hours setting up, performed a couple of hours of construction work, and then took a couple of hours of cleaning up. It would have been much better to temporarily close the line, do all the work required, and do it in a relatively short amount of time (months instead of years). While this would be disruptive in the short run, there are solutions. For instance, London could have converted the streets above the line under repair to an exclusive busway routes at grade, taking general travel lanes to serve the displaced demand.

²⁵ (Wolmar 2002; Jupe 2011).

INDIANA TOLLWAY. Private financing doesn't require a new piece of infrastructure. You can sell an existing asset as well. In 2006, Indiana sold the operations and maintenance of the Indiana Tollway and received \$3.8 billion which then it used to build other infrastructure.²⁶ At about the same time the same purchaser acquired the adjacent Chicago Skyway toll road, hoping to achieve economies of scale. And in exchange, the Australian firm that purchased the toll road was given the right to collect the tolls over a long period of time. It turned out they undertook this transaction just before the Great Recession. Demand turned down and it especially turned down on that road because they raised the tolls more on that road in an attempt to maximize profits. As a result they had to go through a bankruptcy process. The road didn't disappear. It continued to provide service and that's one of the great things (for consumers and the public) about infrastructure: even if the firm goes bankrupt, the asset is still there. In practice, many private toll roads have not worked out financially in the US or elsewhere,²⁷ yet the roads remain open.

²⁶ (Gilmour 2012; Fitzgerald 2015).

²⁷ (Bain 2009).

18.3 *Tender routes*

The transit organization can lower costs by competitive tendering for routes. Just as bus companies today don't manufacture their own vehicles, there is no economic requirement they run and operate the buses themselves.

LONDON BUSES. The London model of bus franchises is informative. Private firms bid to provide service on routes (and collect revenue) for a franchise period. If the route is expected to earn profits at the standard fare, they bid a positive amount. If the route instead is expected to lose money, they bid on how much subsidy is required for them to be willing to operate it. Transport for London monitors quality, collects fares (via the system-wide Oyster transit smartcard), determines routes, and manages stops, stations, signage, and branding, so it appears as one unified system to riders. Bus ridership in London has risen significantly since competitive tendering.²⁸ Strikes are a lot less effective once the city no longer depends on a monopolistic transit service provider and holding a monopsonistic contract with a labor union.

²⁸ (Howes 2011).

²⁹ (Schweitzer 2014a).

³⁰ (Popper 1953).

³¹ (Granger 1980).

Lisa Schweitzer asks²⁹ whether competitive tendering was causal in increasing London transit ridership. Well, as we all know from reading Popper, nothing is provable (though many things are falsifiable), so we cannot prove causality.³⁰ We also know from reading Granger that we can infer causality if we have a plausible causal mechanism and an appropriate time sequence.³¹ Clearly there is a time sequence. What is the causal mechanism? Competitive firms provide better quality of service than did the previous arrangement because they are rewarded for providing better service. Competitive firms have lower costs than long-entrenched public sector agencies.

This clearly doesn't explain everything. Population increases, the congestion charge, increased total bus service, fuel prices, and construction on the Underground also play a part. Yet, it probably does explain something. We doubt that we can show this statistically, since London is only one city and it's not easy to get route-by-route breakdowns of ridership and service quality before and after competitive tendering.³²

³² See the following some more academic evidence on this question: (Cantillon and Pesendorfer 2004; Kennedy 1995; Hensher and Wallis 2005).

However, London, even under Mayor Ken Livingstone (nicknamed '*Red Ken*' for his politics), did not seriously consider undoing bus competition. London did undo the poorly conceived rail competition. Mayor Boris Johnson subsequently reversed the westward expansion of London's vaunted Congestion Charge. He

also reversed the introduction of ‘Bendy Buses’ (articulated buses) and introduced a new double-decker bus. So undoing policy was on the table. From this we infer that it is working and one of the causes of ridership increases.

To be clear, the evidence is that differently structured (more monopolistic) franchises awarded in other UK cities did not see similar ridership increases, so the answer is quite complicated about how to configure tendering to maximize consumer welfare, and experimentation is probably required. Just giving the system away is certainly not the answer. Having the franchises be of a limited duration (for instance 5-7 years) is better than a 20-30 year franchise. This is feasible for buses, the ultimate in mobile capital. It would be much harder for a traditional utility where the infrastructure is expensive, embedded in the ground, and long-lived.

18.4 Thought experiment: Auctioning green time

Eddie, a traveler in a hurry arrives at a traffic light from the East. He would pay up to \$18 to save an hour. Sue, a less-hurried casual traveler arrives from the South, she would only pay \$6 to save an hour of travel right now. Who gets the green light, who gets the red? Presently this is decided without consideration of how much Eddie or Sue would be willing to pay to save a few seconds or a few minutes. No one has the ability or the authority to make a transaction occur where Eddie can pay a few cents to Sue and get the green light, while Sue waits for the light to change. Until recently, this was because it was technologically infeasible, but in recent years, advances in transport signal technology and real-time wireless vehicle-infrastructure communications have made this once impossible transaction possible to contemplate. Now it is institutional constraints that prevent this from happening. Traffic signals are in almost all towns, cities, counties, and states publicly owned and managed. Imagine instead that this was a service that private firms would bid to supply.

A new organization, LightSpeed Traffic, has paid your city \$100,000 a year for the privilege of managing traffic signals. Instead of this being a cost center for the city, it is now a revenue generator. Why do they do this? A private operator is able to use traffic signals more efficiently from an economic perspective than a public agency. They can obtain revenues from sources such as:

- Acting as the facilitator of transactions between travelers as described above to minimize weighted travel delay, Eddie pays \$18/hour (30 cents a minute) and saves a minute, Sue is

compensated at \$6/hour (10 cents a minute), and LightSpeed Traffic keeps the difference, 20 cents a minute, to cover the costs of operating traffic signals, paying the city for the franchise, and earning some profit for shareholders. This could scale up, by summing all of the traffic from each approach, and multiplying by their respective values of time.³³

³³ See for instance (Vasirani and Ossowski 2011; Schepperle and Böhm 2009; Shantharam et al. 2013) for illustrations.

- Providing real-time traffic data to a new generation of GPS companies that aim to provide routing information to travelers. By investing in the signals and sensing technologies around the intersection (and at nearby intersections they also manage), LightSpeed has accurate estimates of arterial travel time, and can make predictions about future travel times, data that is extremely valuable to those providing real-time advanced traveler information.
- Administering red-light running cameras.
- Advertising at the traffic signal when it is red.³⁴ Like transit companies who sell advertising on buses and bus stops, traffic signals have laid out before them a captive audience that might be interested in real-time information, especially information that was customized by place and traveler. LightSpeed has the authority to coordinate advertising with traffic signal timings. Not making the light extra long to force drivers to wait, but simply to use variable message signs to display ads when the light is red anyway, and to benefit travelers by displaying real-time travel information when the light is green.

³⁴ See the patent: Traffic-light timed advertising center <https://patents.google.com/patent/US5150116A/en>.

Presently a few companies operate traffic signals under contract to municipalities, notably in Sandy Springs, Georgia.³⁵ None yet use signals innovatively as described above.

³⁵ (Segal 2012).

Obviously this can get quite complex: there may be more than one approaching driver, how do you decide the baseline to estimate vehicle time-saved or time-list by adjusting signal timings, how does this work in networks instead of just isolated intersections.

But scarce resources (like two vehicles seeking to use the same space at the same time) can be allocated in many ways other than arbitrarily or first-come first-serve, to the benefit of all. Sometimes the best solution is a yield sign, sometimes a stop sign, sometimes a roundabout, sometimes a traffic signal, sometimes a grade separation. To be clear, it is not always a traffic signal. When it is a traffic signal, there might be some merits to thinking creatively about the organization and operation of the market that is created by the rationing of time for the benefit of all.

18.5 *Asset recycling*

Asset recycling is not taking the concrete from old roads and turning them into new roads. Instead, it is financial, where roads are turned into dollars which are turned into roads. Your state has a piece of infrastructure. The infrastructure has a revenue stream that, with proper management, generates enough money to pay for operations and maintenance, and then some. The state can retain the asset, or sell it. If it sells it, where should the money go? If the money goes into building a new piece of infrastructure, Australia calls it ‘asset recycling.’ The Commonwealth (national) government likes these deals so much, it kicks in 15% to the states to sweeten the deal.³⁶

This is, to be clear, a form of privatization. The advantage of privatization is getting the money the asset generates up front, rather than over a long period of time. In addition, private organizations may be able to manage the asset better (though this is not clear). Also, private firms can often collect revenue (or more revenue) that for political reasons the public sector is unable to, for instance toll roads that under state hands might be reverted to ‘free’ roads. Everyone agrees that private toll road operators have to collect revenue, not everyone agrees that states should put tolls on public roads. The framing matters.

In Australia, the public sector is using asset recycling as a financing technique to build projects, sell them off to the private sector, and then use that revenue to build more projects. Rinse, repeat. Because they are infrastructure, these assets will continue to serve the public (though undoubtedly with higher user fees, but less public subsidy from non-users). But because they are so large and risky, and often require eminent domain, it is difficult to convince the private sector to build them without public backing.

There are also profits in parking meters. Chicago leased their parking meters to a private firm. The city received a lump sum payment of \$1.15 billion in exchange from Chicago Parking Meters, LLC, which replaced all the meters and raised prices, and is currently on track to recover their costs by mid-2020s, with over sixty years remaining on the lease.

Utilities and transport services can use private equity and bond markets to unlock value. How much capital would a well-governed mass transit utility with actual users be able to raise if sold to pension funds or the stock market? How much would a toll-road network be worth?

Lisa Schweitzer writes:³⁷

³⁶ See (Poole 2016; Robert W. Poole 2018; Varn and Kline 2017; Australian Government 2014) for further discussion.

³⁷ (Schweitzer 2014b).

³⁸ Milliband was a famous British Marxist. His sons rose to the top of the UK Labour Party in the early 21st century.

[T]ransit's assets are worth more as assets because we all know the taxpayer will buy them back if private sector managers allow things to go pear-shaped. If there is something that, over the course of its history, has been 'too big to fail', it is transit. From the municipal bail-outs of holding companies in the mid 20th century to the devastating strikes that occurred before then, disrupting transit service in the pre-auto world paid out well for both capital and labor. It was textbook Ralph Milliband.³⁸ So we should think Uber-level values with a bail-out and buy-out guarantee – which is basically what just about all major infrastructure transfers to the private sector turn out to be given enough time, save for some examples in Asia.

So she is skeptical of private investment. We don't blame her, we are not investing our retirement dollars in new rail infrastructure either. But there are many lessons here.

An investment that produces a stable rate of return, even if low, is extremely valuable as a financial instrument for annuities and retirement plans. The Ontario Teachers' Pension Plan now owns a share of the Channel Tunnel among other infrastructure assets. UniSuper, a large superannuation fund (retirement fund) for university employees in Australia owns a large share of TransUrban, a large, publicly traded toll road operator in Australia and the US.³⁹

³⁹ Disclosure: Through no fault of his own, as a feature of being employed at the University of Sydney, some of David Levinson's retirement funds are tied up in UniSuper.

Investing in new infrastructure is a lot riskier than investing in already built infrastructure. The early financiers of the Channel Tunnel got wiped out twice, similarly the Dulles Greenway and many other privately funded pieces of new infrastructure that were either more expensive than expected, or built too far in advance of demand – yet the physical thing remains, so the public risk is relatively low.

Unproductive assets should be retired. We have a few in mind, but we suspect most fixed assets (aside from selected intercity rail, commuter rail and streetcar lines) in US transit are redeemable, and all the modern buses are as well, as they can be redeployed.

Utility Models

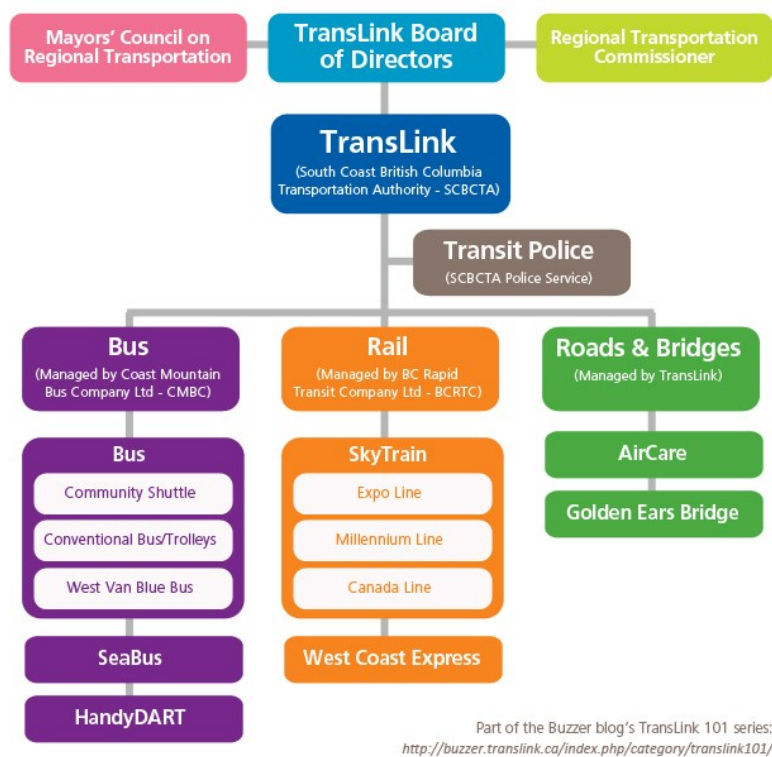


Figure 19.1: TransLink structure.

We have considered public and private ownership,¹ of specific facilities and services and who provides the service. This chapter deepens the question from ownership to organization, exploring the idea of utilities for both public transport and roads.

¹§18.

19.1 *What is a Utility?*

Peter Norton says “A public utility was not just an enterprise ‘of real public importance,’ but also one in which competition was unfeasible.”² Competition is unfeasible because a utility is a natural monopoly. It has high fixed costs and low variable costs. So unlike many sectors, competition actually drives up costs (since the fixed costs are spread among fewer rather than more users). In short no one will go and build a competing road or rail network in most places.

² (Norton 2011).

Many utilities share with transport systems the characteristic of having a networked structure. Most, if not all, of these utilities are operated on the basis of a payment-for-use system. Utility pricing varies regionally, some locales vary prices by time-of-day, and users often have the option of choosing different rate plans. These models are never strict ‘marginal cost pricing,’ but they may improve upon average cost pricing. There are strong parallels between public utilities and transport services, though some differences exist in the nature of the services consumed, the role of technology, and the structure of institutions and decision making.³

³ (Hillsman 1995).

Water faces similar difficulties as transport in the ambiguity of appropriate property rights. Institutional reforms began in the 20th century to better allocate water resources and to improve the efficiency of water use. Water changed from being perceived as a free good to a scarce economic good.⁴ Institutional reforms differ by political setting and social environment.⁵ Decentralization (from central to state and municipal governments) took place in Mexico and Brazil, while corporatization and privatization occurred in Chile, Brazil, France, United Kingdom, Australia, and New Zealand, among others.

⁴ (Saleth and Dinar 2004).

⁵ (Saleth and Dinar 1999).

Hillsman suggests four categories in which utilities have developed to manage demand:⁶

⁶ (Hillsman 1995).

- Altering infrastructure,
- Packaging services,
- Substituting technologies, and
- Changing the price of service.

Transport agencies have considered all of these, but implemented them weakly. In reverse order: prices are largely invariant, bundling and packaging of services is not considered when looking at pricing, infrastructure is hidebound to engineering standards, and difficult to modify, and technological (modal substitutions) are not viable for

most passenger or freight users.⁷ One could easily imagine more creativity on the part of road providers in all of these aspects. The constraints on the application of creativity are due to the engineering culture in a public agency, where risk-taking is discouraged if not punished, and certainly never rewarded.

With some modification, it seems possible to transfer the utility model of governance to road transport. This model separates the organization delivering the service from the client, is subject to rate regulation, and implements a more direct, user-pays system of financing. This model could depoliticize management of the existing transport system. Whether rate regulation is in fact *economically necessary* is the subject of debate; for instance Stigler and Friedland argue there is no difference in prices in the electrical sector due to regulation, because electricity is competitive with other energy sources in the long run.⁸ One expects from experience with other utilities, toll roads, and road concessions in other countries that it would be *politically necessary* to have some public guarantee of an upper bound on the rates a road utility could charge, as provided by a regulatory agency.⁹ The risk is that an upper bound on revenue would be too tight, resulting in financial losses (and one of the causes of municipal takeover), as occurred in the then private mass transit sector throughout the US in the early to mid 20th century.

Such a system would transform but not replace public highway or transport authorities as the party responsible for providing and maintaining roads. One example of a transport system that has transitioned to more of a utility-based model is the road authority in New Zealand.¹⁰ This system was designed to be self-financing, with what was originally called the National Roads Board allocating charges among users on the basis of costs incurred. Three types of costs were identified: load-related costs, capacity-related costs, and driver-related costs (covering signing and other costs not related directly to road use).

There are other elements of costs not included, such as *access costs* (the cost of accessing the network from land and the cost of a connected network, which can be separated from capacity costs (related to the width of the roadway), and load costs (related to the thickness of the roadway), and *environmental costs* (both how the system deteriorates due to weathering independent of use, and how the environment is degraded due to use).

Vehicles are split into two classes on the basis of weight, with vehicles less than 3.5 tonnes paying a charge in the form of a fuel tax. In the US, Oregon has a weight-mile tax for heavy trucks.

⁷ Most US residents have few options for switching modes, driving is the default mode as other modes are too time consuming, inconvenient, unsafe, or have some other flaw.

⁸ (Stigler and Friedland 1962).

⁹ We note that Virginia currently does not have an upper bound on their variable tolls designed to manage congestion. In this case we are not directly writing about congestion, but investing in and maintaining the overall road network. We also note that as of this writing there are Virginia politicians trying to pass legislation that will establish an upper bound.

¹⁰ (Starkie 1988).

Heavier vehicles pay a distance license fee, which is essentially a form of weight-distance tax. Such a system is relatively straightforward and requires minimal new technology, leading to low collection costs compared with most proposed road pricing systems. Newbery and Santos have also estimated the costs and relevant charges for a similar, though hypothetical, system of user charges for the UK.¹¹

¹¹ (Newbery and Santos 1999).

19.2 *TransLink: organizing transport like a utility*

TransLink is the multi-modal transport organization for Greater Vancouver, BC, and it is unlike what we see in the United States. It could be thought of as a multi-modal transport utility with autonomy constrained by oversight. Figure 19.1 shows an organization chart. TransLink describes its organization in a long, though well-done and readable, report:

The province agreed to provide six cents of tax room from the provincial fuel tax, which would be a major funding source, and also give the [Greater Vancouver Transportation Authority] (GVTA) the parking sales tax revenue. The GVTA would have the ability to generate a steady stream of revenue through levying taxes; however, any increase in taxes would have to first be approved by the GVRD board. The only increase the GVTA could implement on its own was to transit fares.

...

"You can look at it as if it's no different from water or sewers, or any other kind of utility," Cameron said. "So what are the financing principles behind those utilities? They're user pay, essentially. You use water and sewer revenues to pay for water and sewer services, and the aim was to get transport services to be autonomous, self-financing, self-constructing utilities."¹²

¹² (TransLink 2008).

One of the key points to consider is that metropolitan Vancouver has a transit mode share of 21%, comparable with much larger Toronto and Montreal (though behind metro New York's 30%, it is well ahead of Seattle's 9%), despite ranking 31st in population in North America as of 2015. Some of that has to do with institutional factors and governance.

Canada should consider exporting this model of governance to the US.

19.3 *Transit should focus on core markets*

Some transit markets (which we call the *core*, and are typically in the center of metropolitan areas) are better than others. Deciding which

mode to take is not generally a marginal decision. For a given market (origin-destination pair), almost everyone chooses either one mode or another. Very few markets are competitive. To be competitive, the alternatives have to be perceived as having almost exactly the same travel time, frequency, reliability, and other characteristics, or the advantage in one characteristic has to be exactly offset by another.

Consider downtown Minneapolis. Under some assumptions, transit mode share to 'downtown' for peak hour work trips is 44%. We expect this is not uniform, for some origin-destination pairs, transit mode share rises higher than 44%, and for others it falls far below 44%.

Downtown is one kind of market, and larger, denser cities than Minneapolis will even have higher transit mode shares. Non-downtown is a different kind of market, with a transit mode share much closer to zero. The mode share for all work trips in the Twin Cities region holds around 5%. If the mode share is 44% for trips going to downtown Minneapolis (and much higher than 5% for trips to downtown St. Paul and the University of Minnesota), then it must be lower than 5% elsewhere. Across the United States, the transit mode share for all trips is under 2%.

The [Mohring effect](#)¹³ implies there are two equilibria because transit is a positive feedback system (and the primary competing mode, automobiles, is a negative feedback system).¹⁴ The more transit riders, the more revenue, the higher the rate of buses (or trains) per hour (and the better the service, as with more riders, express and other services can be offered).

At high levels of ridership (relatively high mode shares), losing a few riders because of small random exogenous shock, or even a bus-full will not be noticed in the travel times (schedule delays) of the remaining riders. At medium levels of ridership, losing just enough riders to result in service cutbacks will have a noticed effect on headways and thus schedule delays, driving transit ridership down further. This is the vicious cycle that has destroyed transit in most of the US. As students of systems theory know, vicious cycles are just virtuous cycles in reverse. An exogenous shock increasing transit use should increase supply provided, reducing waits, and thus further increasing use. We imagine this might be a sharp sudden increase in the price of fuel. This only happens if the supply system is responsive, which typically happens with free markets, but not necessarily under government management.

So in a world where people have the ability to have an automobile, either many travelers (in a narrowly-defined market) almost always use transit, and the frequency is high (the case for

¹³ §A.4.

¹⁴ This model was developed in (Levinson and Krizek 2008; 2017) and extended in (Bar-Yosef et al. 2013).

selected to origins to well-served activity centers), or almost no one does (the case almost everywhere else).

This says that fixed-route transit investment should be highly, highly focused in markets (OD pairs) where it is, or can cost effectively and financially sustainably become the dominant carrier.

THE TRANSIT GOAL SHOULD BE REFRAMED. Transit is not competing to double its regional mode share for all trips from 1.5 to 3%. It is competing to increase its mode share in specific markets from 40% to 60% to 80%, and to add markets where it can dominate. (Regional mode share might be a byproduct of that, but it is an improper goal). Otherwise, the service is spread out like peanut butter and does nothing well.

To be clear, we cannot put the genie back in the bottle. As a society, almost all new urban form since the 1920s has been climbing up Mt. Auto and down Mt. Transit.¹⁵ Every change we make to the network to make it more convenient for cars makes it less convenient for transit. Every change in land use adapted to the automobile is maladapted to an environment served by transit. It would probably take another century of concerted effort to reverse this, and there is scant evidence that efforts are concerted.¹⁶

Yet, there remain markets, mostly those that existed before the 1920s, where transit is competitive, and even dominant. Instead of chasing butterflies, transit systems should focus on its dominant and dominatable markets, and play to its strengths. Everyone can think of local butterflies that are diffusing rather than concentrating transit's attention.

If, where, and when the transit service is good, it will attract transit-oriented people to organize their lives around transit services, and may encourage new people to become transit riders. It might even encourage [transit-oriented development](#)¹⁷ to shelter those transit-oriented people, and transit-oriented stores and businesses to serve them. It cannot do this where the service remains poor.

CARS NEED NOT FAIL FOR TRANSIT TO SUCCEED. Each mode has its use, the problem comes in deploying a mode where it doesn't fit (like urban freeways, cars on campus, or low volume fixed route transit). If we don't acknowledge the misfit, we will waste scarce resources (time and money) that could be better spent elsewhere. And let's not kid ourselves, these resources are scarce. If we don't acknowledge the subsidies and the cross-subsidies in the system, people will continue to behave inefficiently. The argument that

¹⁵ This analogy was discussed in more depth in (Levinson and Krizek 2005; 2008; Levinson 2015a).

¹⁶ As of this writing, among major cities, only Buffalo, Hartford, Minneapolis and San Francisco have eliminated minimum parking requirements citywide in the US. This step is fundamental to building cities conducive to creating access without driving.

¹⁷ §11.20.

because there are subsidies in other modes, we should have subsidies in our mode is wrong. Two wrongs don't make a right. A bad subsidy does not justify more of the same, it justifies removal.

RETRENCH TO A PROFITABLE CORE. Each money-losing route should be cancelled or operated under contract by the transit utility in exchange for specific revenue from the jurisdiction that route serves. Transit organizations would at least break-even on the operation of the route. The 'deficit' would shift from the transit utility to the public sector, which would have a clearer picture of the costs of its wants. Focusing on the core requires cutting service elsewhere.

Mass transit systems in the United States are collectively losing money hand over fist. Yet many individual routes (including bus routes) earn enough to pay their own operating (and even capital costs). But like bad mortgages contaminating the good, money-losing transit routes are bogging down the system.

We can divide individual systems into three sets of routes:

- Those routes break-even or profit financially (at a given fare). This is the 'core.'
- Those lines which are necessary for the core routes to break-even, and collectively help the set of routes break-even. These are the 'feeders.'
- Those lines which lose money, and whose absence would not eliminate profitability on other routes. These routes ensure spatial coverage of more territory, typically lower density suburban areas, rather than intensively operate with higher frequency in urban markets. Jarrett Walker calls them 'coverage' routes to emphasize their spatial coverage (at the expense of service frequency).¹⁸

¹⁸ (Walker 2011a).

The rationale for this is to think about, and organize mass (or public) transit agencies as transport operators first, not welfare organizations. Our view is as much about separating the transit agency from the welfare function as about whether unprofitable routes should be dropped. That is, transit agencies don't do well as dual purpose agencies. Organizations, like products perform better with clear missions.

It would be much cleaner to give them a single mission: provide these routes and make money/break even. They would earn revenue from customers on profitable routes, and from society at large on 'coverage' routes that society explicitly chooses to subsidize

despite their inability to make money. The operating agency should not be making welfare decisions, that is better done through an explicit public policy process.

Thus agencies should be considered public utilities rather than departments of government. Utilities, by their very name, provide a useful service for a price to their users.

Local transit systems should identify and propose to retrench to the financially sustainable system, and present local politicians with a choice.

If local politicians want additional 'coverage' services, they should be presented with a cost of subsidy per line, and then can collectively choose which lines to finance out of general revenue, as this is primarily a welfare rather than an transport function. The Paris transit system, RATP, charges local and national governments a 'compensatory indemnity' for keeping fares below the break-even price.¹⁹ Governments recover this from an employment tax.

¹⁹ (Wolman and Reigeluth 1980).

In other words, public transit organizations would present the public with a bill for these money-losing services (the subsidy required in order to at least break even on operating them (i.e. the difference between their revenue and their cost), and not be expected to pay for them out of operating revenue.

If the cost of those lines is deemed too expensive (i.e. the politicians are unwilling to pay for them with general revenue tax dollars), they should be canceled. Transit agencies would no longer be losing money, they would now be break-even or slightly profitable. They might even pay a dividend to their owners (the general public).

General revenue (the Treasury) would of course now be losing money, we didn't pull resources from thin air. But since this is a social welfare/redistribution function, that is perfectly appropriate. This would entirely change public and political perception of transit services. It might also result in fewer bad routes being funded, since it would be crystal clear where the subsidies lay.

The 'which routes to fund' decision should be revisited periodically.

We suspect no transit fare increase would be enough to pay for the entire fixed route transit system as we know it in the US. The demand would diminish sufficiently so as to keep the maximum revenue collected below what is necessary for the full transit system. This is why we suggest separating it out. There is a profitable core. We should try to figure out what it is.

The point is not that transit should be profitable (though that would be nice), but that if it is useful, it should break-even (i.e. be

financially sustainable without depending on others). If people are not willing to pay for the service, it is insufficiently useful. We think the public utility model is valid (and historically how transit had been organized in the first place).

NETWORK SHAPE AND DESIGN SHOULD REFLECT THE FOCUS ON CORE ROUTES. Hub and spoke (or radial) networks, which are conventional for many transit systems, are an example of how network design affects the usefulness of the overall system. Transit networks are good at getting people into and out of central business districts (the hubs) with few transfers but leave those who travel suburb to suburb or anywhere other than downtown in the cold. These networks are not optimal for access to opportunities anywhere else.

As most job growth in the US occurs in the suburbs, historical hub and spoke networks don't help most people get where they need to go. Yet, for transit, the best market remains its traditional market, serving downtown and large employment centers from pre-1930 residential areas. Whether it should play to its strength or follow its customers is an important strategic question transit agencies face. Most, like the Twin Cities, have chosen to reinforce the pre-War employment nodes (downtown), with some radial extensions to the largest suburban activity centers (Mall of America, Eden Prairie). In contrast, some cities are rethinking their transit networks so that they better reflect where people need to go. With the assistance of transit consultant Jarrett Walker, Houston recently redesigned their highly radial, CBD-serving bus network as a grid, refocusing resources to improve frequency on selected routes and streamlining the network. The old network and new network are shown in Figure 19.2. This improved access.²⁰

²⁰ (Palmateer et al. 2016b).

19.4 *Think of transit like a club*

Users of transit should be treated as members of a club. Transit is most like a club good,²¹ and the relevant club-members should be its users and potential users. Users should be financially incentivized to get season or annual passes (paid monthly with bank debits) and become 'members' of the transit system rather than pay-as-you-go 'riders,' which will encourage more usage, and many users to get subscriptions so they have the easy option of taking transit. As with many museums and zoos and other clubs, membership should be reciprocal, so joining the Twin Cities Transit System gets me 'free rides' in Chicago or New York. This will

²¹ §A.

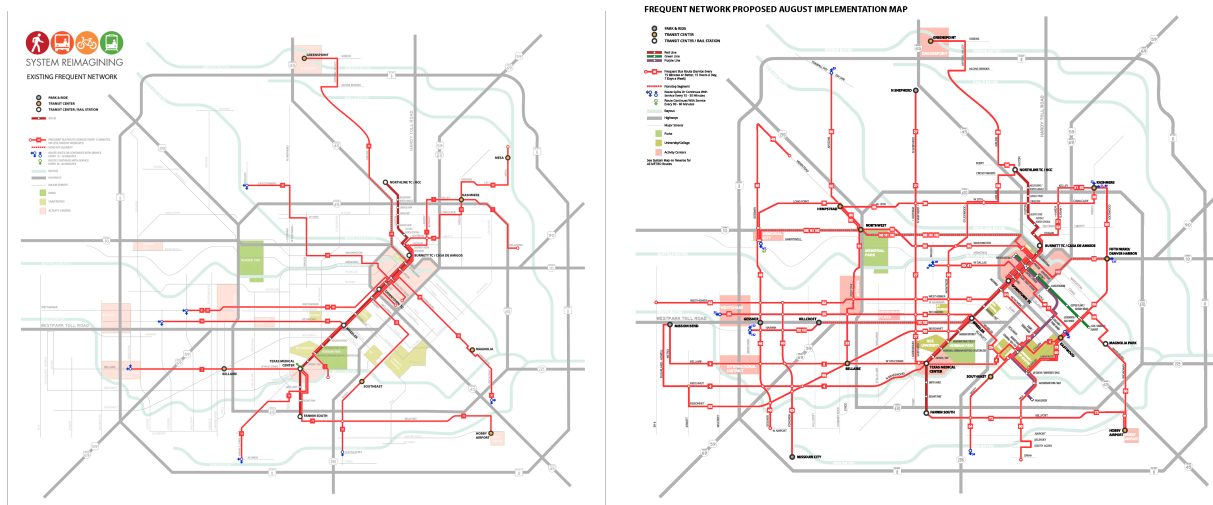


Figure 19.2: Reimagining Houston Frequent Transit Network.

²² Most people who use transit only use transit in one or two cities per year, so this would be relatively minor. Again this is a case where contracting out (to Visa or Mastercard, for instance) might be valuable.

²³ In the Twin Cities 9.5 million rides of a total of about 71 million (which depends on what numbers you use) on Metro Transit

²⁴ A U-Pass (for University of Minnesota students) is only \$97 per (4 month) semester, with subsidy from the University.

increase the perceived ownership that passengers have for the service.²²

Many people pay for transit on a per use basis, either by cash or with a stored-value card. Others²³ use a season pass for ‘unlimited’ use (‘unlimited’ use still has limits, for instance in the Twin Cities you still need to pay for services > \$3 per ride, i.e. Northstar). For instance, a Metropass is \$76 per month, if you belong to an organization with 10 or more subscribers, and allows unlimited service.²⁴ There are many options.

For the individual traveler, \$76 per month is worthwhile at current fares if you make at least 34 peak trips (17 days per month) or 43 off-peak trips (22 days per month), i.e. if you are essentially a daily user for commute trips, or use it for a lot of non-commute trips as well.

Several (perhaps obvious) points:

- There are probably many existing riders who would benefit from a Metropass who don’t get one (this would cost Metro Transit money).
- Possessing a Metropass would induce the holder to make more trips by transit (since the marginal cost of use would now be zero).
- At a relatively lower price, more people would get a Metropass. This may or may not increase Metro Transit’s revenue. This can be achieved either by lowering the price of the Metropass or increasing the price of non-Metropass use.

- We would expect more people to have passes than use the passes on the system every day (not every pass-holder need be a daily rider). People pay for the option of not having to think about price.

What benefits do clubs offer? Let's look at the examples of other public institutions that use the club model: museums, zoos, public radio for some ideas:

- Unlimited transit rides in your home city,
- Reciprocal unlimited transit rides in other cities,
- Free entry to the local transport museum,
- Discounts from participating merchants and at events (like sports games, shows, or concerts),
- A tote bag or mug,
- A newsletter or magazine,
- Two free taxi rides per quarter,
- Free parking! (At park and ride lots? In downtown?), and
- Eligibility to vote on governance (such as a Member's Board which has input into real decision making).

While the tote bag will be popular, there are limits to the ancillary benefits of membership in an organization, the main thing has to be admission to the service that organization provides.

The more important aspect of membership is that it changes the perspective from being a customer to being a member, if not owner, of the system. Members of a club want there to be more members, as it helps spread the costs and raises money for the services provided. Members advocate for the organizations they join. Members feel part of a 'larger social whole.' Members help maintain it, since it is their 'property.' A lot of this is 'reframing' but the psychology is important here, people act differently based on whether they feel they have real input into decisions and real effect on outcomes.

Some cities have Bus Riders Unions, but they are often at odds with the transit agency. Almost everywhere has an Automobile Association (Minneapolis and St. Paul each have one), about which members have warm feelings since they help start cars when the battery dies, or change a tire, or tow it when something else breaks. Transit workers are members of their union. Even transit agencies are members of APTA trade association. We cannot find an example of a transit system that organizes and treats its riders as members.

Why shouldn't riders be members of the non-profit cooperative utility that provides them transport services on a regular basis? And why shouldn't they help govern that organization?

19.5 *Enterprising roads*

Policymakers should permit states to form independent road enterprises that would manage roads that are part of the National Highway System (and any other roads states wished), raising revenue from a variety of user fees, including road pricing, gas taxes, and facility tolls.²⁵ To facilitate these enterprises, federal law should be changed to permit states to implement tolls of various kinds on Interstate and other highways. The tolls could provide off-peak discounts, thereby beginning the process of using prices to reduce congestion.

²⁵ This section and the next are adapted and extended from (Levinson 2012).

Today's congestion is evidence that the current governance structure of American highways is unsuccessful in managing a basic collective action problem. Discussions of road pricing for financing and congestion management in the US still largely assume that our existing institutions would do the pricing. But to date, this has essentially been a non-starter. Institutional reforms are needed to reconfigure state departments of transportation as public utilities rather than departments of government. Then Americans will stop seeing roads as a public service funded out of the pot of general revenue and start seeing them as a fee-for-service proposition paid for by direct user charges.

While everyone wants a free ride, dedicating highway user fees to transport is widely preferred to more general revenue sources. Although this already occurs in most states and at the federal level, the public does not realize it, and therefore is not aware of a great deal of evidence about how this approach can work in practice. Establishing a clearly differentiated *road enterprise* would change how people think about transport, as well as how transport is managed.

This approach would separate the organization delivering the service from the client, be subject to rate regulation, and would involve a more direct, user-pays system of financing. This model could partially depoliticize management of the existing transport system.

Thus the road enterprise approach would be better positioned to rationalize the transport network than today's state departments of transportation, subject as they are to the [politics of their governors and legislatures](#).²⁶ It would have the authority to downgrade or

²⁶ §D.

abandon roads that are uneconomical and the obligation to maintain the rest at a high quality of service, including operating them, maintaining, and reconstructing as necessary. It could identify roads that should be expanded and new connections that should be built. New road construction would still be subject to the normal political process, but would occur only if there were long-term funding in place to pay for it directly or repay bonds or loans.

19.6 *Minnesota Mobility: A scenario*

It is 2025 and a new road enterprise, Minnesota Mobility (M^2), which was spun out of the old Minnesota Department of Transportation (MnDOT), has recently taken over the operations and maintenance of the state's main roads. This new organization emerged from the local culture of Minnesota and has quickly become a popular institution, responsive to the needs of its citizens, who now see clear value for their transport-related payments.

Revenue

M^2 has the authority to raise revenues from road users via fees assessed at the fuel pump (for older vehicles), or by using special, in-vehicle equipment that charges according to mileage and axle weight (for newer ones like autonomous and electric vehicles). In both instances, fees are subject to regulatory approval by the state's Public Utility Commission (PUC).

In urban areas there is a peak period congestion surcharge on all roads. This has reduced congestion, but has not eliminated it. For those who require reliable transport and guaranteed travel times, there is a complete network of MnPass managed lanes throughout the Twin Cities. These also contribute revenue to M^2 . All trucks pay a new weight-distance charge that varies by axle loadings and the route used. Automatic Vehicle Identification has improved considerably, dramatically reducing collection costs, and all in-state cars have an account with M^2 for their vehicle license. For those that don't drive in the peak period, don't use MnPass, and don't pay at the fuel pump, a monthly bill is issued. Out-of-state drivers are billed too, thanks to a cooperative agreement among all the state road enterprises, and the few remaining DOTs in states still using the old model.

In addition to conducting normal road operations, M^2 exports services related to ramp meter control and snowplow technology,

where it has expertise. This gives it an additional source of income. It manages traffic data collection and freeway management from a multi-state traffic management center in the suburb of Roseville, using the most advanced technology available. Neighboring state transport organizations, as well as counties within the state of Minnesota, contract with M^2 to manage their traffic using ramp meters. They find this less expensive and more effective than doing it themselves.

M^2 clears snow from major local roads (under contract to counties and cities) and from freeways in adjoining states. They do this using advanced technologies such as largely autonomous snowplows, which through advanced GPS technologies can traverse and clear snow-covered roads despite the absence of visible road markings. With recent improvements in weather forecasting, M^2 is able to pre-deploy snowplows along corridors likely to be hit hard and make better use of its expensive capital-intensive equipment.

Regulation

The Minnesota Public Utility Commission's mission is to create and maintain a regulatory environment that ensures safe, reliable and efficient utility services at fair and reasonable rates.²⁷

²⁷ (Minnesota Public Utility Commission 2018).

The PUC has an important role. By regulating rates, it in effect determines the quality of service on the roads. M^2 's natural instinct is to push for higher revenues and to produce a higher quality service, for instance by resurfacing roads more frequently, making lane markings more visible, or clearing snow-covered roads more quickly. The PUC's job is to compare the rates and quality of output in Minnesota with other states and to determine whether its residents are getting value for money. M^2 's board of directors plays an important oversight role, but its main responsibility is to the road enterprise and its shareholders. The PUC, by contrast, explicitly serves the interest of service users. While M^2 's users and shareholders are similar groups, they are not necessarily identical.

Responsibilities

M^2 provides a number of services related to infrastructure, traffic, seasonal operations and licensing. The major categories are listed below:

INFRASTRUCTURE SERVICES	TRAFFIC OPERATIONS
<ul style="list-style-type: none"> • Pavement maintenance, repair and reconstruction; • Bridge maintenance, repair and reconstruction; • Sidewalk maintenance, repair and reconstruction. 	<ul style="list-style-type: none"> • Traffic enforcement (police services, red light cameras, speed compliance cameras); • Parking enforcement; • Traffic control (signs, signals and markings), including monitoring.
SEASONAL OPERATIONS	LICENSING
<ul style="list-style-type: none"> • Snow removal; • Street sweeping. 	<ul style="list-style-type: none"> • Driver Licenses; • Vehicle Licenses; • Revenue collection.

Differences

Unlike MnDOT, but like some other state DOTs and the Australian road enterprises, M^2 has the authority to license vehicles to use roads, and to license drivers. It has a special safety and security service that enforces its rules on road use. As a result, it also incorporates what used to be the Department of Driver and Vehicle Services and the Minnesota State Patrol (once part of the Department of Public Safety). M^2 can also develop land adjacent to existing state roads, generating additional revenue by capitalizing on the accessibility benefits it creates. M^2 has not yet done very much of this, but there is potential.

M^2 differs from MnDOT in several other significant ways. For example, it is not responsible for the construction of new roads. This responsibility now lies with land developers, newly chartered turnpikes, and local governments. After construction, some of these new roads are turned over to M^2 for operation, management, maintenance and reconstruction. However, many remain as private turnpikes or toll roads, integrated into the network through individually negotiated interoperability agreements, which enable M^2 to handle billing.

While it does have a voice on state and local transport planning, M^2 is not responsible for this. It plans for its own future, and makes decisions about the capacity required on its existing roads, but for the most part broader strategic planning takes a back seat to management.

Like MnDOT, M^2 is not responsible for the operation of transit services, which the state has separately contracted out through the use of Public Private Partnerships. Aid to local governments for roads and transit is distributed directly by the Department of Finance. However, such funding has been considerably reduced, leading to ongoing discussion about the role of local vs. state government in the management of roads and other transport services.

Ownership

Minnesota Mobility was chartered to provide road services to the people of Minnesota, and as such, the citizens of Minnesota are, collectively, its owner. Its board of directors comprises members nominated by the state governor and approved by the state legislature. They serve staggered terms, which helps prevent M^2 being overly swayed by the political process and ensures a degree of continuity in management. There have been suggestions that M^2 's board should be directly elected, but so far Minnesotans have been content to let their democratic representatives attend to personnel details. The board of directors selects a chief executive officer and has approval rights over the CEO's other 'C-level' officials. The board sets the CEO's salary through a compensation committee. It also approves M^2 's annual budget, revenue requests and major expenditures. Unlike MnDOT, M^2 's budget does not have to be approved by the legislature. Nor is the legislature responsible for the rates it charges.

Employees

The employees of M^2 no longer work for the state of Minnesota, and therefore are not subject to the vagaries of state politics and the occasional state shutdown. Roads have become a public utility and they must be kept operating. When M^2 was formed, MnDOT employees were allowed to apply for positions in the new organization, but they were not guaranteed jobs. About 10% did not apply (many choosing to retire) and about 15% were not rehired. The old unions did not carry over and, so far, employees have not chosen to form any new unions. The state absorbed the pension system of the old MnDOT, giving M^2 a clean slate.

Reporting

Every year M^2 publishes an annual report identifying revenue from users, from services and from other sources, as well as expenses. It also publishes an important time series of performance indicators demonstrating the quality of pavements, roads, lane markings, snow clearance, traffic congestion and so on. The organization has set goals for performance in each area, and budgets enough funding to achieve these goals. Nonetheless, every year, after it has invested funds and ensured sufficient capital for present operations and contingencies, M^2 runs a small surplus. This comes in large part from the congestion surcharge, which earns money by charging more in the peak periods.

Dividends

Even after making deposits to a reserve fund, which helps smooth financial flows and ensures that long-term maintenance and reconstruction is properly financed, M^2 is able to put part of its annual surplus toward paying a dividend to its owners – the people of Minnesota. M^2 could probably run a larger surplus by raising user fees to ‘what the market will bear,’ but that would be politically contentious and not in line with its public service mission (nor would it be approved by PUC, its regulator). As it is, there is no more chatter about how state roads are subsidized by taxes: the argument has moved on and everyone acknowledges that roads are paid for by their users (and then some). The annual road dividend warms the heart of local taxpayers, coming as it does every April 15.

Future

There has been talk of M^2 fully taking over the road and highway departments of counties and cities in Minnesota. Doing so would relieve the local governments of a major expense that must be paid out of property tax revenues, as local governments are unable to assess gas taxes under current law. Furthermore, just as phone companies and electric utilities own both ‘the last mile’ and ‘the linehaul,’ there is now a debate about whether there should be vertical integration in roads. Some argue that the economies of scale this would allow, and the professional management and specialization it would entail, could reduce costs and improve quality significantly. There is even discussion of M^2 merging with road enterprises in neighboring states in order to achieve additional economies, but these have not yet advanced very far. A few states

have even begun to sell shares in their road enterprises on the stock market or to large pension funds, in an effort to raise additional capital and introduce private-sector efficiencies. However, most states, Minnesota among them, have resisted investor-ownership so far.

Clearly, some legal changes were needed to implement a dynamic, politically independent system like this. But they were neither unimaginable nor unfamiliar, as aspects of this approach were already in place on some US highways and turnpikes. Once some states started down the path toward road enterprises, others quickly followed.

19.7 Takeaways

So who should own and operate networks? There isn't an obviously optimal network ownership structure. We argue for a regulated public utility model for roads and a regulated utility model for transit networks to achieve economic and societal goals. Public transit networks built to achieve political goals will be too large and may end up distorting travel choices people make. Justifying transport investment because of [construction jobs](#),²⁸ is a good way to make sure the transport network is always expanding whether we like it or not. Minimum parking requirements in the zoning code ensures that the parking nodes on the network continuously expand, which leads to more driving than we want. Yet networks built by oligopolists and monopolists to strictly be profitable through user fees may not be large enough for broader goals and will maximize private profits at the expense of the public good.

Here are some takeaway points about network ownership:

- Monopoly ownership (public or private) may be needed to support large capital expenses.
- However, most transit need not be monopoly provided, as the main costs are labor and vehicles. Buses use shared road space in most cases. There are economic stability issues if routes or stops are not regulated. This regulation may be either by the public or by the industry itself through route associations, where the latter are often enforced in developing countries with real or implied violence.²⁹
- Public networks often attempt to anticipate need or are too large for actual demand. This is because public networks are expanded due to political reasons (such as the Interstate network) or have dedicated revenues without direct user fees.

²⁸ §10.

²⁹ See (Klein et al. 1997).

- Public transit networks are justified on projected demand, which is often distorted by optimism bias.
- Private networks will react to demand to maintain profitability. This means expansion may be slower and contraction may be faster than public networks.
- Indirect effects from network expansion, such as land development or positive returns to scale may affect how much investment networks receive.
- Private actors will sell off or abandon links and facilities on networks that are unprofitable. Publicly owned networks have a much harder time reducing the scope of networks.

Politics and Politicians



Figure 20.1: Metro Transit Southwest LRT (Green Line Extension) Ceremonial Groundbreaking, November 30, 2018. Many politicians are smiling, claiming it will be a success despite decades of setbacks. Photo by Metropolitan Council of the Twin Cities.

POLITICS BALANCES THE IDEAL WITH THE POSSIBLE. In a first best world, we do the best thing assuming everything else about the world is ideal. In a second best world, we do the best thing recognizing everything else about the world will remain as dysfunctional as it already is.¹ We identify four sources of differentiation that people of good will may hold when disagreeing:

- *Values.* Many political debates are because people disagree on *values*:² some people think a lot of freedom is more valuable than a little bit of safety, some may be more afraid, while some other people capitalize on that fear; some think the life of the unborn has value to society, others think a woman's body is her own.
- *Time frame.* Debates occur because people cannot agree about the relevant *time frame*: some think earning more dollars today will enable us to more efficiently solve tomorrow's problems, others think we need to sacrifice economic growth to reduce pollution now.

¹ See (Lipsey and Lancaster 1956).

² §17.5.

- *Knowledge base.* A few debates are because people don't accept *common facts*: we think very few people attended the President's inauguration, he purports to believe it was the biggest ever.
- *Worldview.* Some debates are because people disagree about the *model of the world*: we think most threats (future dangers) are home-grown, others think they come from outsiders. This relates to the last two, but is distinct because it deals with future facts, not something evidence-based.

Often political debates are about how much change is possible. This depends on the model of the world. If our voter votes yes now, and yes passes, the world moves somewhat in the right direction, but thereby releases the pressure to move farther in the right direction. If she votes no, and no passes, society doesn't make the move, and she hopes a better offer will be on the table later. There is no guarantee this will occur, and in the meantime she may have lost some benefits. Say, in the US context, a voter believes in what a real Green Party³ would stand for, but does not think the Greens will win, should she vote for the Democrats instead, which will be closer than the Republican alternative to her preferred outcome? Given the current US single-member district, first-past-the-post,⁴ no ranked-choice voting system, that's a logical choice for most environmentalists. Voters are choosing the second-best rather than nothing. They can make a protest vote, or they can try to move the system. If everyone in her admittedly progressive Minneapolis district thought the Greens had a chance, they would act as if the Greens had a chance, and the Greens would have a chance. The possible is determined by what everyone thinks that everyone else thinks everyone thinks.

³ The US Green Party at the national level, unlike that in some other countries, is of course highly problematic from an environmental and political perspective, and took funding from Russia in 2016.

⁴ The candidate who receives the most votes wins, even without a majority.

PEOPLE BECOME POLITICIANS TO BE SOMETHING OR TO DO SOMETHING. We favor the latter. There is no point in being a politician unless you want to accomplish something that improves the world around you. Sure some people get into politics for personal self-aggrandisement and wealth enhancement, but for most politicians there is in the end no reason to accumulate power but to do something with it, that is to impose their values, their preferred temporal horizon, their perception of reality, and their model of the world on the government. Further, they must have the notion they can do this better than anyone else, not just better than a person in the opposing party, but better than the next best person in their own party.

Power is a means to an end, and usually the end is more significant than private wealth. Some politicians may forget this along the way, many try to combine their values with wealth-enhancement, but hopefully they remember near the end of the careers the whole point of doing what they did and expend some of their power to achieve their original aims.

It is the advocate's job to move the politician in a particular direction. This extends the Overton Window of acceptable discourse.

It is the politician's job to compute how far to move both to maximize future power by ensuring his constituency is along for the ride and to actually move in the 'right' direction consistent with the reason for being a politician in the first place.

20.1 Political parties, three axes, and public transport

As a gross over-simplification, the current rap in the US is that Democrats like trains and Republicans like roads, Greens like bikes, and Libertarians like tolls. No party stands up for buses, which are by far the most used transit mode.

Transport policy has become politically divisive, especially for local politics which have been less constrained by national parties in the past. Why should something as fundamental as infrastructure policy lead to such vitriol and moral superiority?

We need a good framework to start working through why advocates of a particular transport technology are so assured of their rightness. In the current environment, there is no room for reasoned critique of transit, roads, etc., or reasonable agreement that these things are important.

Maturity (peak travel) is one explanation. Transport policy has become ideological because there are not clear priorities for new investment for any mode, and spending on maintenance doesn't make anyone happy, it just prevents future unhappiness.

Another plausible explanation is that as federal dollars have become more competitive (for all things) strict party loyalty is more important at the local level. This means that federal representation sets priorities for non-formula spending and if you want any money you best conform to that vision. As Republicans dominate rural areas and Democrats dominate cities, party loyalty helps determine what transport policies you favor.

Three-axes model

If you take a charitable view of the world of ideas, and politics, you can adopt the three-axes model of political beliefs popularized by Arnold Kling. People have internal value systems that array on three axes. He writes:

My hypothesis is that progressives, conservatives, and libertarians view politics along three different axes. For progressives, the main axis has oppressors at one end and the oppressed at the other. For conservatives, the main axis has civilization at one end and barbarism at the other. For libertarians, the main axis has coercion at one end and free choice at the other.⁵

⁵ It is Sometimes Appropriate ... Posted on December 4, 2012 by Arnold Kling. For more see (Kling 2017)

For convenience we have mapped these to the three-point French Revolutionary slogan of ‘Liberty, Equality, Fraternity.’

In brief:

- Liberty is associated with Libertarianism, and privileges individual freedom.
- Equality is associated with modern ‘progressivism’ and social justice, and thus, in the US, the Democrats, and prioritizes fairness (with all that means).
- Fraternity (or community), considers most important group loyalty, respect for order and hierarchy, and obedience to the social order, preservation of civilization, abhorrence of barbarism, and is associated with modern American ‘conservatism’ and thus, in the US, Republicans.

There are important core-values associated with all of the axes, and society requires a tension between them to be successful.

Lacking social justice, (which would be a problem of itself), the out-group will not be loyal to the system. If out-groups provide value to the other groups (such as by increasing international trade, or advancing science, or providing labor, or cooking tastier food), this is a major loss. Even without a clear racial out-group, people naturally form divisions over even trivial distinctions.⁶

⁶ (Sherif 2010).

Without any individual freedoms, (which is bad of itself), and rewards and responsibilities associated with personal action) there will be no innovation or progress.

Without any respect for order, there will be no stability or government or framework under which the others can operate. There also needs to be defense against the outsider.

It is entirely reasonable to believe that society has moved too far on one axis and away from another. It is entirely unreasonable to

believe only one axis has value. Absolutism on any of these axes (as a core belief) is politically unsustainable. Feigned absolutism as a way of opening the Overton Window of Discourse⁷ may be, however, a logical strategic move, depending the degree to which people believe you are true to your beliefs.

Nevertheless, regardless of your political persuasion, everyone should like buses. The rationale for the various political persuasions are presented below.

Democrats

Today Democrats are associated with rail. The reason we hear from politically connected folks is construction jobs and unions and real estate development and property owners. Of course their more urban constituency prefers rail to roads, while higher densities fit with their urban ideal. To the extent that Democrats have an underlying principle of ‘equality’ and ‘social justice,’ they should support buses.

Why Democrats should want to prioritize improving buses:

- Buses serve more people than trains (since they are more cost-effective), so bus improvements benefit more people.
- Bus riders are much more likely to be Democrats since they have lower average incomes compared to rail users and the general population.
- Buses generate more operating jobs than trains, as bus drivers are labor and buses don’t carry as many passengers as long trains.
- Buses are harder to automate than trains, so driver jobs are longer lasting jobs. While there are fewer construction jobs than rail projects, those are short term anyway.
- There are more manufacturing jobs per passenger. Bus manufacturing is more likely to be local.⁸

Republicans

To the extent Republicans uphold the value of ‘fraternity’ and support the existing ‘social order’ they should endorse buses.

Why Republicans should like buses:

- Buses are much less expensive to build than rail, and thus much more cost effective per passenger served in most markets. If you are a Republican who wants to provide public services (that is,

⁷ (Lehman 2014).



Figure 20.2: Buses are S.M.A.R.T. in Starkville Mississippi.

⁸ (Li et al. 2015).



Figure 20.3: Buses are coldly efficient, like this Metro Transit bus in Winter.

you believe in governing as the outcome of victory), you want to provide them effectively.

- Bus transit helps more lower income workers get to jobs than a similar investment in rail in most places. Employed people have a stake in the system.
- Republicans can foster the many private bus operators serving US cities, including many of the suburban bus companies.
- By supporting buses Republicans can show that they care about an actual problem their constituents have and work to improve how bus service is supplied.

It should be noted the late, racist, Republican, rail-advocate Paul Weyrich continues to be trotted out by ‘conservatives.’ Weyrich was embraced by the rail community despite admitting his ‘sordid grab bag of lamentable beliefs.’⁹ His argument was that trains serve white middle class republican voters, so (a) Republicans should support their constituency (not much about actual core values of balancing budgets or efficiency required), and (b) rail advocates should accept the support as the coalition to build trains needed to be large due to their large public cost.

We believe there are some values more important than transport technology preference, and it is sad to see others making sordid bedfellows.

Libertarians

Libertarians uphold the value of ‘liberty,’ freedom of action. Providing mobility for those without effective options increases overall freedom.

Today libertarian (if not ‘Libertarian’) transport policy (best represented by the Reason Foundation)¹⁰ favors moving towards road pricing, public private partnerships, contracting out, HOT lanes, and privatization as strategies, but doing so intelligently. All of this will have the consequence of raising the cost of travel by automobile and result in fewer vehicle miles traveled than current policies. It also suggests that if auto travel is more expensive, the use of other modes will increase. One of those other modes is buses.

Why Libertarians should support buses:

- Buses are more easily contracted out or franchised to private firms in a competitive way than infrastructure itself (as in London), which is embedded capital subject to natural spatial monopolies. The evidence for the ease of contracting is the extent

⁹ (Trains for America 2008).



Figure 20.4: Buses are franchised out in London, like this Routemaster, and in many places have exclusive lanes.

¹⁰ See especially the new book *Rethinking America's Highways* (Poole 2018).

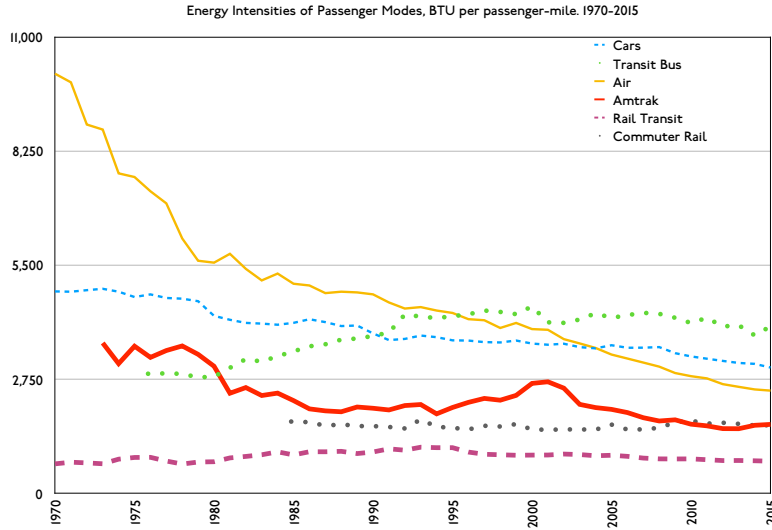


Figure 20.5: Energy Use by Mode. Source: (Oak Ridge National Laboratory 2018). Note: 1 Kilowatt hour/passenger km = 0.000471551 BTU/ passenger mile.

of contracting (many non-US cities already contract out or franchise bus services).

- Bus routing and scheduling is also more dynamic and adaptable to actual and changing needs given an environment with ubiquitous roads and evolving land uses.¹¹
- Buses can take advantage of High Occupancy/Toll lanes, and integrated busways/HOT lanes are useful for suburb to city radial commuting markets, sharing the fixed costs of expensive facilities over more users than exclusive transit ways, without a time penalty.
- Buses enable people without other options to travel farther than no motorized transport at all, increasing freedom.

¹¹ (Klein et al. 1997).

Greens

Greens are most associated in the US with non-motorized transport. As pedestrians ourselves, we see the many advantages. While many more people could walk than do, and many others could re-arrange their home and work locations over time to enable one or more members of their household to walk or bike, getting people to move home or change jobs to minimize travel costs is a big ask. Creating new (and re-creating existing) urban places (instead of new suburban places) aligns with the philosophy of some Greens. Economic development and real estate tend to be local issues, and downtown real estate in particular is now an odd ally of the Greens.

The next best thing to minimizing distances through changes in relative location and land use is getting people to their destinations in an energy efficient way.

While Greens don't fit cleanly on the three-axis model, their beliefs are probably most related to social justice and equality, but extending the object of justice from people to the environment as a whole (that is valuing the environment for its own sake, not just for the sake of future humans). If we had to give the Greens a word to go along with the French *Liberté, Égalité, and Fraternité*, it might be *Durabilité*.

Why Greens should want to invest in buses:

- Buses (when more fully occupied) are more energy efficient than other modes, and electric buses show promise to improve this even more. In practice as shown in Figure 20.5, buses are less energy efficient than cars on average, due to low occupancies in off-peak and suburban services, though the marginal passenger incurs almost no additional energy consumption.
- Buses (and vans) are community transport where people can meet their neighbors and the driver, stops are community hubs.
- Rail construction (or any infrastructure construction) is highly disruptive to fragile eco-systems and highly energy intensive, so the payback period for CO₂ emissions may be decades, if at all.¹² If you think that CO₂ is something to worry about, improving bus service in a matter of months should be far more valuable than potential reductions more than a decade away.
- Making buses work better adheres to the adage used about housing that 'the greenest buildings are existing buildings.' The greenest transport is more intensively using existing transport. Even with new rails, existing roads will remain. We should use them wisely.

¹² (Chester and Horvath 2010).

Instrumentalism

¹³ Merriam Webster defines instrumentalism as 'a doctrine that ideas are instruments of action and that their usefulness determines their truth.'

To be clear, everyone near power is instrumental¹³ – the Democrats favoring rail and construction in general due to the association with unions and Republicans with their association with 'free' roads, or Paul Weyrich with his justifications for suburban commuter rail.

Thus it represents a situation where values are an instrument to build a coalition to obtain power, as opposed to using power to support core values. The Libertarians and Greens are purer of heart as they are farther from actual power.¹⁴

¹⁴ And perhaps they are farther from actual power because they are purer of heart. The causality is mutual.

Despite the transport logic, trains are more politically popular. A new train on new track in an exclusive right-of-way is a more

comfortable ride than a bus on beat-up pavement shared with cars, trucks, and other vehicles.

People riding buses are unhappier with their commute than commuter train riders in Montreal (though about the same as Metro riders).¹⁵ Walking and biking make their commuters happier still. By implication Greens are happiest with their non-motorized travel.

¹⁵ (St-Louis et al. 2014).

The unhappiness with bus use occurs for a variety of reasons. In part poor people (are rightfully) not as happy about the state of reality than those with more resources and opportunities. In part bus riders are likely less happy because of the stigma¹⁶ and disrespect¹⁷ associated with buses and because of the underfunding of buses due to that stigma and disrespect.

¹⁶ §11.12.

¹⁷ §11.11.

While that may seem like bad news for an argument about investing more in buses, we think it is an opportunity. It is the mode most easily improved. Thus it is where happiness can be most readily increased by reorganization and increases in service, better integration of information technology, and enhancing the environment around stops and stations. We should increase the dignity of riding the bus.

Bus has received far less attention than rail. In the Twin Cities, the number of planners and engineers, leave aside dollars, per bus rider falls far short of the number per rail rider. In addition to high level design questions, attention to local details does matter, and does pay off. Attention is required.

Typically, comparisons between bus and rail contrast existing local buses, which are old, noisy and slow, with new trains. New beats old. Where buses have been used to provide high quality, speedy, quiet (electric), lane separated transit in good markets they perform really well. Finding ways to make buses work requires cooperation of the bus operator (public or private) and the infrastructure provider (almost always the public).

The land use argument is one of choice. Zoning¹⁸ can be changed without building rail, but no one seems to be doing that. Economic development¹⁹ effects have been demonstrated for significant bus improvements.

¹⁸ §13.

¹⁹ §11.20.

There is so much more than can be done with buses, and can be done within a year, that it is depressing (if not insane) so few even try.

Take away a few parking spaces, and even some general purpose traffic lanes, and put some paint on the road (reallocating road space to buses), then see how people like the new bus versus the old bus.²⁰

²⁰ (Hyman 2010).

Reallocate transit dollars and see how many new high frequency bus services can be deployed for the same resources otherwise dedicated to a short rail corridor.

The mainstream political parties tend to exist for political purposes more than for pursuing a coherent set of policies. The evidence suggests no one in power actually wants less public spending, and arguments are about marginal increases in spending. Yet most of the public is far more interested in being able to get around affordably and easily, reaching their valued destinations, than what technology is used.

20.2 *Trust as a positive externality*

²¹ (Fukuyama 1995).

A few years ago, Francis Fukuyama put out a book called *Trust*.²¹

He argued that social capital was a positive externality that produces trust, and civil society only succeeds if people have trust in the words of others, i.e. they believe others will do what they say, and of course that only emerges if people do in fact do what they say.

The 2008 Global Financial Crisis resulted in banks being unwilling to lend to other banks for fear they wouldn't be paid back. That fear arose because, in fact, some banks now defunct, did not pay back loans. The system of trust failed. One (or in this case a few) bad players shattered the system of trust that had a positive externality in encouraging lending.

The economy only works because of beliefs that a small piece of paper (a dollar bill) will be redeemable by complete strangers for something valued more highly than a piece of paper. Through this belief, we can replace barter with a money economy, we can lend money we don't have (à la banks) and create wealth by investing in wealth-creating instruments now rather than waiting until sufficient resources are acquired.

It is hard to say how many years advanced economically society is because of borrowing, but one imagines it is probably decades. If the ability to borrow collapses, not only does society not grow faster, society will grow slower as old debts still need to be repaid out of current income, leaving little available out of current funds for investment.

Positive externalities operate in two ways, as a virtuous cycle (more of *A* begets more of *B* which begets more of *A*) or in reverse as a vicious cycle (less of *A* begets less of *B* which begets less of *A*). Changing direction requires an external shock – a collapse of trust

for instance, or a major infusion of trust through a government intervention.

The classic examples of *virtuous and vicious cycles*²² in transportation and public transport ridership and service, which grew as virtuous cycle from the 1880s until the 1920s, and where after the past 60 years of vicious cycle operation, most of the US has very little service and ridership left (despite 30 years of very expensive investments). In the US, transport is ‘pay as you go’ at the federal level, which may very well be a source of our under-investment, as there is an unwillingness to capitalize now our benefits from investments due to the positive gains they will provide in the future. If we don’t want the entire economy to follow the path of public transport in the US, something must be done.²³

As suggested above, the collapse of trust is warranted when the players are not trust-worthy. Even if there were an external insertion of funding, if the behaviors of the players reveal their true preferred actions, and these actions are not regulated in a transparent way, the system cannot necessarily be restarted without new rules to establish trust. As President Ronald Reagan was fond of saying “Trust but Verify” (*“doveryai, no proveryai”*).

The same will hold true of bankers, who not only seemingly distrust each other, but also should distrust the previous failed systems of verification (bond rating agencies) that were insufficient in providing advance warning of emerging problems.

Verification only works with transparency, where the actions of players are observable by all.²⁴ This occurs on open regulated markets.

²² §A.4.

²³ Without falling into the trap of endorsing the first policy that comes along: Something must be done. This is something. Therefore, it must be done.

²⁴ David Brin developed this idea, which has come to be known as *sousveillance*. (Brin 1998).

20.3 *Lying as a vicious cycle*

In response to the Global Financial Crisis, fortunately, wise leaders stepped up to the occasion, and while their actions were imperfect and too few bankers went to jail, the system of trust that drives the economy of civilization was maintained.

We have recently decided as a civilization to elect unwise ‘leaders.’ Leaders for whom the old joke:

How can you tell when a politician is lying?
They are moving their lips

is no longer funny.

If we cannot trust the word of our so-called ‘leaders,’ can we trust their minions, or anyone in government who reports to them and does their bidding. And as lying becomes the norm, won’t the entire

system of trust break down? Why should one cooperate with the dishonest? And if you cannot tell who remains honest, or no-one remains honest, mutually beneficial cooperation, the cornerstone of civilized society, crumbles.

Ensuring trust, that someone will do what they say (i.e. pay you) after you do what you say (perform a service) is tricky, but extremely valuable. The value arises in being able to trade with strangers, not just brothers and cousins. It permits specialization in a way unfathomable to Adam Smith.

To enable the smooth function of trust, society developed an entire legal system to avoid cycles of vigilante vendettas that arose after perceived or real slights. But as liars take the helm, the legal system itself becomes corruptible. We have a chain where at one end are the judges, appointed over time by the liars. In the middle are prosecutors, typically appointed by the same, and at the other end are the police, with their own biases.

So if I loan you money, and you don't repay, and I sue you, but you control the courts, or just have friends in the right places, I will not get repaid. If I know that, I won't loan you money. Instead, if I am not careful, you will just take my assets, and I will call the police, and they will shrug their shoulders, and I have lost my money anyway. Smart people outside the power structure will try to emigrate from such a low trust society, leaving it with a brain drain and less voluntary trade, less specialization, so ultimately it will under-perform higher trust societies over time. This is bad on dimensions beyond the economic.

Trust can decay from the bottom up or the top down. The disintegration is surely faster when it starts at the top. This lack of trustworthiness pervades government, not the least of which are transport agencies.

20.4 *It's a success*

There are no more common words to hear shortly after the opening of a new rail project in the United States than 'It's a success.' The forecast that an agency or its supporters will declare a project 'a success' is far more accurate than the forecast of ridership or costs.

For instance, the Washington Metropolitan Area Transit Authority (WMATA), the agency which operates Washington, DC region's Metrorail claims:²⁵

Metro: Silver Line ridership remains strong

Metro today provided updated Silver Line ridership information showing that, less than two months after opening, the new line is

²⁵ (Washington Metropolitan Area Transit Authority 2014).

already performing at 60% of its projected ridership for the end of the first full year of service. As of last week, an average of 15,000 riders are entering the system at the five new Silver Line stations on weekdays for a combined 30,000 trips to or from the new stations.

In the planning process, Silver Line ridership was projected to reach 25,000 boardings at the five new stations after one full year of service.

Metro estimates that the Silver Line is currently adding approximately 6,000 new riders – making roughly 12,000 trips – to the Metrorail system each weekday. The balance, approximately 9,000 riders, are primarily former Orange Line riders who have switched to the Silver Line.

Some outlets²⁶ have used the word ‘success’ to describe the line, as did then US DOT Secretary Foxx. Certainly it is still early, but the Silver Line didn’t exceed first year forecasts. Maybe it can exceed final year forecasts, or even have benefits in excess of costs, or somehow reduce inequity in the Washington region, or lead to economic development, or any number of other objectives hoisted on transit lines. It is arguably successful from a project delivery perspective, in that it was delivered, and opened for service, but that seems a narrow way to think about success.

²⁶ (Warmoth 2014).

In contrast, another new start, the Minneapolis – St. Paul region’s Metro Transit Green Line has done a bit better, even with all sorts of traffic signal timing issues. It too is heralded as a success,²⁷ with ridership exceeding forecast year ridership about three months in. While many of its riders were transfers from existing bus services, it clearly is serving more new riders for less money than the Silver Line.

²⁷ (Murphy 2014).

Which is more successful? Which is a better investment? Time will tell, and we will leave that to the reader’s judgment.

We have three hypotheses as to why these words are so common.

- It may be that all projects are successful. For this hypothesis to hold, we would need to see enormous transit market share across the country after several decades of more than 20% of all US government transport funding going to transit.²⁸ Sadly the evidence suggests otherwise.²⁹
- To many people, simply building transit is considered a success. In his book *Railtown*,³⁰ Ethan Elkind declared Los Angeles a transit success simply because they passed some taxes and built a few new rail lines – nevermind that overall transit ridership has been declining for decades, and has dropped by about 20% between 2013 and 2018.
- It may be that the appearance of success is important, independent of the actual facts on the ground. Calling ‘success’ aligns you

²⁸ (Pew Charitable Trusts 2014).

²⁹ (Bureau of Transportation Statistics 2018).

³⁰ (Elkind 2014).

³¹ (Alpert 2014).

³² (Bajarin 2014).

with ‘Team Transit’³¹ and rewards your supporters. The illusion of success is critical to obtain future funds. No one wants to give money to an agency that actively (if honestly) claims ‘It’s a failure’ or ‘It’s a disappointment,’ or ‘We’re still perfecting it,’ or even ‘It’s a hobby.’³²

We hold this last explanation as most likely. This is not to say there are no successes in urban rail transit. There are many. Starting in 1863 with the London Underground, rail transit globally had an extraordinarily good run for 60 years. In the US, it sort of petered out after that for the next 50 years or so, though in other countries, rail transit has continued at various levels of strengths.

³³ (Wikipedia contributors 2018g).

Some of the lines in the past 40 years have been more successful than others, all depending on your definition of success. The best systems³³ remain the ones built in the early 20th century, with only LA’s Metro Rail breaking the top 5 in riders per mile (and DC’s MetroRail coming sixth). Yet all new systems have been declared successful by somebody – even the relatively low ridership per mile lines like Tampa’s TECO line,³⁴ or Charlotte’s Lynx.³⁵ Some are even pre-declared, like The Tide in Hampton Roads,³⁶ or Dallas.³⁷

³⁴ (The San Diego Historic Streetcars Blog 2011).

³⁵ (Light Rail Now Project Team 2008).

³⁶ (Virginian-Pilot Editorial Page 2007).

³⁷ Point:(Pantell 2008), Counterpoint:(Nicholson 2016).

We find it hard to see the \$6.8 billion being spent on the Silver Line so far to add 6,000 riders (12,000 trips) as an unqualified success. We would find it hard to see meeting these low forecasts as a success either. This is more dollars per passenger than many commuter rail lines spend, as shown in the [next section](#),³⁸ which few outside the agencies themselves are calling a ‘success’ (the advocates of course do use that exact word).³⁹

³⁸ §20.5.

³⁹ (Northstar Corridor Development Agency 2012).

If spending \$2 billion added zero or negative riders, that would be truly surprising, indicative of active destruction of money. We will just state there were plausible alternative uses of the funds that would have improved society in other ways. Every expenditure has an opportunity cost.

DO NOT BELIEVE OR REPEAT THE PRESS RELEASES OF AGENCIES AND ADVOCATES UNCRITICALLY.

20.5 *Mischief in Minnesota*

When Minnesota’s Northstar Commuter Rail line was just a glint in the eyes of exurban Republicans, they distributed the promotional material shown in Figure 20.6.

Ridership has not come close to the promised 3 million annual.

Ridership on the Northstar commuter rail line will be about 20% less than forecast in its first year of operation, prompting one member of



NORTHSTAR COMMUTER RAIL

CORRIDOR CONGESTION PROBLEM

The Northstar Corridor is the fastest growing corridor in Minnesota – with traffic congestion to match. The Twin Cities metro area had the fastest growing congestion problem in the nation between 1984 and 2000.



INTEGRATED SOLUTION

The 30 local counties, cities and townships that make up the Northstar Corridor Development Authority (NCDA) chose commuter rail as the key component of an integrated transportation improvement strategy. Northstar has completed an alternatives analysis, an environmental impact statement and preliminary engineering.

NORTHSTAR BENEFITS

- Commuter rail is the most cost-effective alternative for this corridor. While an exclusive busway would cost about \$10 million per mile to build, adding lanes to Highway 10 would cost \$12 million per mile, Northstar commuter rail will only cost \$3.7 million per mile.
- Northstar commuter rail will be fully operational in just four years.
- Northstar will bring an estimated \$1.2 billion in economic development to the corridor and will create nearly 13,000 new jobs.

STRONG LOCAL SUPPORT

- 77% of Northstar Corridor residents support commuter rail.
- Local governments have agreed to fund 10% of the capital cost.
- Business, labor, veterans and other groups have actively supported the NCDA in the effort to obtain funding from the State of Minnesota.

IT JUST MAKES SENSE

Northstar is strongly supported, clearly needed, cost-effective and flexible, will reduce traffic congestion growth and spur economic development.



Northstar Corridor Development Authority
 2100 3rd Avenue, Anoka, Minnesota 55303-2285
 (763) 323-5700 1-888-475-6752 Fax: (763) 323-5652
www.GoToNorthstar.com

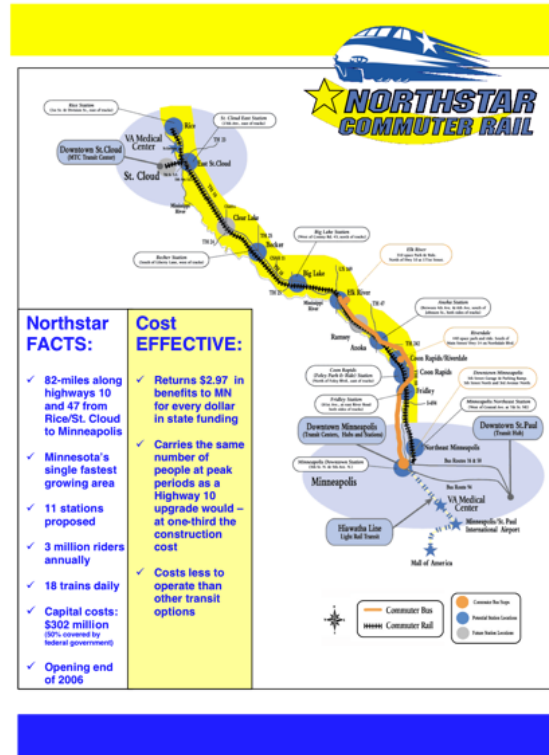


Figure 20.6: Northstar Commuter Rail promotional material promised 3 million annual rides.

the Metropolitan Council to question whether the \$317 million project was worth it.

Officials had projected 897,000 riders total for the Northstar in 2010; after nine months – including the Twins' season – it now looks like the annual ridership figure will be 715,000.

In fact, Ridership on the Northstar stayed within a disappointing range from 2010 to 2017, ranging 700,000 to 794,000. There is no evidence this line will be shuttered anytime soon. Yet, when do we actually declare a failure? The article continues:

As a result of the lower numbers, Met Council board members voted unanimously Wednesday to reject fare increases that for more than a year had been set to go into effect Nov. 15.

"Do we ever unravel a transit project that is not successful enough to sustain itself?" asked District 2 Met Councilmember Tony Pistilli.

"I'm not saying we should unravel Northstar yet, but do we have a definition of 'failure'?" Pistilli, in life outside the Met Council, is chief appraiser and vice president of consumer banking risk management for US Bank.

District 3 Met Councilmember Robert McFarlin, head of the transport committee – and former interim head of MnDOT – said that

“unraveling would be extremely difficult. I believe it’s incumbent upon us that we give what’s in place the best possible shot to succeed.”

But McFarlin added that Pistilli’s question “is an excellent one, and [the lower Northstar ridership numbers] should give us pause looking at other projects that are on the drawing board.”

In fact, other Commuter Rail lines in the Minneapolis - St. Paul region have been put on the back burner since Northstar’s disappointing arrival. While they continue to be studied, none have been funded for construction.

What should have been the expectation? It depends on who you believe. Consultants will vary, some in doubt depending on who is paying the bill. In this case, there were three benefit/cost analyses conducted prior to opening. Anton, Lubov, & Associates (dated April 17, 2003) conducted an economic analysis of the line, and in contrast with a 1998 Parsons-Brinckerhoff BCR of 0.26, or a very optimistic 2002 MnDOT BCR of 0.84, they came up with an incredibly optimistic BCR of 1.15 for the line.

⁴⁰ Parsons-Brinckerhoff rebranded to WSP in 2017.

Cudos to Parsons-Brinckerhoff.⁴⁰

Proponents will argue that the full line (to the metropolis of St. Cloud, population 200,000) was not built, which is of course true. However the unbuilt segment was expected to be a worse performer than what was actually built.

At current ridership, this amounts to about a daily \$61 round trip capital cost and \$28 round trip operating cost. Or \$89 per person per day.

Fares are up to \$6.25 one-way, or \$12.50 round-trip. Assuming most trips pay the full fare (which they don’t), the daily subsidy would be about \$75 per day per rider.

⁴¹ Actually, very much like the Pope.

Decommissioning should be an option. Not every scheme works. Unlike the Pope,⁴¹ the Metropolitan Council and State Government are not infallible, and need not defend every decision of every predecessor. Every continued dollar supporting the long-distance commutes of a few exurbanites is a dollar that cannot be spent on providing more access to more people.

If this kind of mischief were unique to Minnesota, we could pass it off as a mistake. However it is quite common in the world of transit promotion. ‘Strategic misrepresentation’ as it is politely called has been well-documented by John Kain, Don Pickrell, Jonathan Richmond, and Bent Flyvbjerg among others.⁴²

⁴² (Flyvbjerg et al. 2005; Richmond 2001; Kain 1990; Pickrell 1992).

20.6 *Taking credit*

“It is amazing what you can accomplish if you don’t care who gets the credit.”⁴³

⁴³ This is attributed to Father Strickland.

Transport investments are politically popular as they often lead to durable and tangible improvements in people’s lives. Transport investments also offer opportunities to cut ribbons and name facilities to ensure a politician’s memory lives on in perpetuity. The desire to get credit for such investments can lead to trouble.

In 2011 the US Congress passed a law that banned earmarks within spending bills. This ban was politically appealing for conservatives and liberals in that it seemingly ended wasteful spending on ‘bridges to nowhere.’ The federal surface transport legislation passed in 2006 contained thousands of earmarks for specific projects which accounted for 13% of total federal spending. When this law expired the earmark ban was in effect, and it is no surprise that it took years for new legislation to get passed. Without earmarks, congressional representatives didn’t have currency to barter support for broader legislation. While the earmark ban remains in effect, congressional Republicans have made efforts to rebrand earmarks as ‘Congressionally directed spending.’ They should just call it advertising.

Politicians need evidence that they are delivering what their constituents desire, even if what the people want isn’t necessarily the best option. More importantly, elected officials want clear credit for delivering what their constituents desire. Such acknowledgement often confounds seemingly straightforward transport priorities. One example of this is in New York City, where Mayor Bill DeBlasio and Governor Andrew Cuomo, both Democrats, really don’t like each other. While no one sheds tears for their lost friendship, the fact that the Governor is responsible for the city’s Metropolitan Transportation Authority (MTA), which owns and operates most of the city’s transit services, while the Mayor is limited to some appointments to the governing board is problematic for the transit system. Like most transit systems, the MTA depends on subsidy to maintain service and invest in maintenance and expansion. Currently, subsidy comes from a mix of sources, but traditional sources are not enough for the MTA to maintain existing services levels and upgrade the system (including rebuilding subway tunnels damaged by flooding after Hurricane Sandy). As a result, service is declining, which is causing ridership to drop.

Rather than work together to find a solution to the city’s transit needs, the Mayor and the Governor have dug in their heels about

not cooperating. Whatever the personal enmity between them, ultimately this is about who might get credit for fixing the system. The Mayor doesn't want to spend city dollars on something the he feels the Governor will use for acclaim. Instead, the Mayor has developed and proposed a number of highly visible and very expensive alternatives to fixing the subways and buses: new ferry service and a waterfront streetcar. These solutions are projects directly under city control, and have not been part of the long range transport plans of the city and region.

The need for a politician to claim credit for transport is not unusual, but it does affect the types of projects cities and regions will pursue. In many cases, the interests of the public and the politicians may align. In others, not so much. New York City is now spending over \$300 million to expand the new ferry service so that it can service about nine million trips per year, which is about what the daily ridership is for subways and buses combined. If it weren't for egos, and misaligned governance, New York could really have it all.

20.7 *Expertise*

A notable feature of transport is that everyone, citizen and politician alike, believes themselves an expert on their own commute, (which is true) and on transport problems generally (which is not). While no one knows better how to route from *A* to *B* than the person doing that day after day, not the Department of Transportation, not Google Maps, not traffic information services like Waze, we also know that those expert commuters are doing it imperfectly.⁴⁴ Their expertise on a single origin-destination pair, among the millions in any city, does not give them any special expertise on managing the city as a whole. No one fully has that expertise. We do think there are systematic rules that those managing the transport and land use systems should use, rules that say changes to the system should tend to increase accessibility for travelers and potential travelers, and all else equal, a greater increase at a lower cost is usually better than a lesser increase (or decrease) or a higher cost.

Due to the daily failures of transport systems, which are political problems, there is a great deal of skepticism about the competence of transport professionals. Just as respect for expertise has diminished in other sectors of American society,⁴⁵ the respect for the engineers and planners has fallen farther than it has deserved. No sector is perfect, but the recommendations of most transport engineers and

⁴⁴ (Zhu and Levinson 2015).

⁴⁵ (Nichols 2017).

planners and economists when not being leaned on by politicians are generally far better solutions than those actually implemented.

20.8 *Frontiers or values as instruments*

There is no North American metro area colder than Minneapolis- St. Paul that is larger than Minneapolis - St. Paul. It is on the size-cold frontier. The partial converse is true for Phoenix, as it is the largest, hottest region.

On the brawn-brain frontier, Stanford ranks highly, no university with smarter students has a better football team. Cal-Tech might say the same. As might Ohio State in 2015.

Combining different things into a single metric is inherently arbitrary. Economics likes to monetize everything, so instead of noise, we have monetized noise externality, which is directly comparable with monetized time, monetized crash death, and monetized air pollution.

In the end this is sometimes useful, especially at the margins. We have to decide how to spend limited money to reduce pollution vs. increase safety vs. reduce travel time. But this is also problematic, especially when dealing with wholes.

People don't think that way. And people don't think that way because nature doesn't reduce to a single metric. No amount of nitrogen in the air could offset too little oxygen (while 100% oxygen would kill you, so something needs to dilute it). We are advised to have a balanced diet. Some things are inherently un-substitutable, and therein lies a conundrum for comparing alternatives.

Arguments about projects and policies are usually over unstated values not facts. And if the arguments were good faith, people would clearly state their values, agree on the facts, and then some democratic process would resolve the values and achieve compromise, side payments, and so on. People would go home, a decision would be reached, and we could move on with the next thing.

Instead the arguers corrupt truth and self-select facts to achieve rhetorical aims, without consideration of the longer term consequences of devaluing what objectivity actually does exist in the world (it sometimes goes by the name of 'science') and destroying trust in the democratic process in general.

We individually assume that we want to achieve the best trade-off for ourselves (the most house in the best climate) subject to budget constraints. I can have a smaller house in California or a larger one

in Minnesota. California has (or at least had) a better climate than Minnesota.

We assume society also ‘wants’ to achieve the best trade-off, except society doesn’t ‘want’ anything. The simple illustration demonstrates convergence to a single preference is not guaranteed.⁴⁶

⁴⁶ This is the Condorcet paradox.

Everyone has preferences:	From which logic tells us:
• Alice Likes Blue over Green over Red	• Two people like Blue over Green
• Bob Likes Green over Red over Blue	• Two people like Green over Red
• Chuck likes Red over Blue over Green	• Two people like Red over Blue.

So Blue is preferred to Green is preferred to Red is preferred to Blue. Ergo, society does not have well-defined preferences. People are individually just as irrational, since our minds are themselves just a bunch of individually networked neurons. Sometimes I like Blue, sometimes Green, and it may be entirely unpredictable by an observer. Some people are sufficiently self-aware to identify their own contradictions. Walt Whitman for instance said:

Do I contradict myself? Very well, then I contradict myself, I am large,
I contain multitudes.

⁴⁷ (Minsky 1988).

Marvin Minsky described the brain as a *Society of Mind*.⁴⁷ Most people are oblivious to this fact, others in mere denial if not self-denial.

And if people don’t know what they want individually, how can society? We devolve into deferring to the most confident sounding, the brashest, the blow-hardest, the strongest, the wealthiest, to avoid being eaten by the lion.

STRONG OPINIONS, WEAKLY HELD IS A STRATEGY TO ADDRESS THE CONFIDENCE TRAP. Yet if someone changes their opinion, they are criticized as a flip-flopper, and are assumed to be easier to roll in the future.

The best response is perhaps

When my information changes, I alter my conclusions. What do you do?⁴⁸

⁴⁸ This has been attributed, perhaps apocryphally to John Maynard Keynes.

We try to operate at the frontier in production space in economics, anything else is an inferior solution. Why be not as smart and not as strong (good at American Football) as another university? And if we are not on the frontier (football skills vs. IQ) we thought we wanted to be on, redefine terms of the argument (maybe we educate more students or are more equitable, maybe our city is Windier than

any larger city instead of Colder). But we need to be flexible in our thinking and pliable in our goals to have the nimbleness to identify our competitive advantage.

In short, our values are arbitrary, we believe them so as to make ourselves superior in some dimension or set of dimensions, so we can feel good about ourselves and have high status in some clique (which presumably has evolutionary payoff). We convince ourselves that one particular value trade-off is what we actually care about, and internalize this belief so we can better convince others.

Our final quote:

It is difficult to get a man to understand something, when his salary depends on his not understanding it.⁴⁹

⁴⁹ This is attributed to Upton Sinclair.

Transport Poverty



Figure 21.1: Nobody Walks!
Source: Photo by D. Levinson.

When we talk about access as a value that should guide transport policy, we need to address access for whom, not just access to where by what mode. In the auto-dependent US, the mode that offers the most access in most places currently is the car. Yet cars are expensive, and many people struggle with basic access (and mobility) simply because they can't afford it. Transport is the second largest spending category for US households, behind only housing. This is the case even as transport is heavily subsidized, regardless of mode.¹ As discussed in [Subsidy](#),² the general approach is to spread whatever help is offered thinly across infrastructure capital investment. This does little to help those with the least.

¹ It is likely that transport is so heavily subsidized because it is such a large share of household spending.

² §4.

If we view access as a necessary utility, such as energy, then we can supply access to ensure that people aren't left out of the economy. We argue subsidy should be paid directly to travelers. But that is not the world in which we live, nor is there a credible expectation that we will start doing so anytime soon. The reality is that American cities are largely built around the automobile, which means that to access economic opportunity you have to drive. If we accept the US cities are automobile-dependent, and we do, then it follows that people without autos are disadvantaged, as they do not have the thing on which cities are dependent.

One way to think about people at a transport disadvantage is through the lens of transport poverty. The fewer options that people have for getting around, the more vulnerable they are to situations where they can't do the things they need to survive and thrive. Transport poverty may result in social isolation, loss of economic opportunity, or exposure to negative externalities from transport.

For many, the problematic situation of transport poverty should be addressed through investment in alternative modes of getting around and better cities: walking, biking, and mass transit serving denser residential neighborhoods. Density is good, and we largely agree with these ideas, our preferences for density or our concerns about the environment should not come at the expense of people suffering from transport poverty. Society doesn't prevent people heating fuel in the depths of winter just because burning it pollutes the air. Staying warm is more important than being a perfect environmental steward. We should apply the same standard to transport.

Transport poverty hits families in multiple ways. First, there is the monetary cost of travel, in particular the cost of owning and operating an automobile. Second, there are the time costs involved to travel if a car is unavailable. We often hear tales of a benevolent boss or group of co-workers who pitch in to buy a car for someone who walks for hours to reach their job.³ These are not stories that should make us cheer the generous co-workers, but are stories that should alarm us as to just how vulnerable too many people are when it comes to transport.

The time and money costs combine to promote social and economic exclusion among many, particularly people without cars. A story from the Seattle Times illustrates these points.⁴ Simon Nakhale is an immigrant from Kenya whose family relied on bus transit for their first few years in the United States. His bus commute was a four-hour round trip. Eventually he and his family realized this routine was unsustainable and they bought a car. The

³ For instance, Walter Carr was given a car after he walked 12 miles for his first day of work as a mover. His boss found out because he was picked up by the police at 4:00 am, presumably because walking alone at that hour is viewed as suspect behavior (Garrand 2018).

⁴ (Tu 2015).

car not only shortened their commutes, but allowed Nakhale to get a second job.⁵ Too often, cases like Nakhale reflect the relationship between long commutes and low wages. Even with low wages, people will buy cars as soon as they can afford them just to access more opportunity.

Studies of low-income households show that families go in and out of car ownership frequently. One study that uses the Panel Survey of Income Dynamics shows that while 13% of US households are car free any given year, only 5% of households are consistently car free.⁶ This suggests that the value of a car is greater than the expense, even for low income families.⁷ Over the past few decades, a lack of a car has become increasingly associated with poverty.⁸ The income gap between households with a car and those without is greater than households with a college degree and those without, or households who own their home rather than rent. In America, to be carless most likely means poverty.⁹

Banks and automakers have taken note of the importance of auto access. As cars have become more expensive, but also more reliable, auto loans for eight years are now commonplace. A Canadian study shows how high levels of auto dependence correlates with high levels of household indebtedness for car-related expenses.¹⁰ Sub-prime loans and predatory lending are also pervasive for low income households simply trying to buy a car so they can be part of the economy. People on the edge of car ownership are vulnerable to many things, and should be protected.

By reorienting our transport thinking to accessibility rather than mobility, we reward transport choices that take advantage of proximity of activities and diminish the status of higher speed travel, which favors the auto. This will naturally make families more resilient with regard to transport, but also will minimize the necessity of automobile ownership, which should be a policy target ahead of minimizing automobile ownership in absolute terms.¹¹

Transport poverty presents many challenges for the political economy of access. The primary challenge, obviously, is how to ensure that everyone has the access they need to the places they need to go. But supplying access to everyone is at least a straightforward goal. The real challenges are trying to achieve it where there are resource constraints, which depends on how policy is made. Money spent on access for some is money that cannot be spent on access for others. Some (most) people are more concerned about their ability to hold a job than their carbon footprint. We know that during recessions environmental concern declines.¹² Similar attitudes will be held by workers struggling to get by. This

⁵ Whether people should have to work multiple jobs to get by is a separate question.

⁶ (Klein and Smart 2017).

⁷ Each year the American Public Transport Association (APTA) puts out a 'fact sheet' that claims switching from driving to public transit will save a household \$10,000 on average. They promote this as look at how much money is being wasted by people who choose to drive rather than take the bus or train. An alternate interpretation, if their analysis were accurate at all, is that a typical family is willing to spend \$10,000 yearly to have the access a car brings.

⁸ (King et al. 2019).

⁹ An exception to this is Manhattan. Voulgaris et al. (2017) estimate that only 5% of the population reside in what we would consider "old urban" neighborhoods which are easy to live in without a car.

¹⁰ (Walks 2018).

¹¹ As we have argued elsewhere in the book, drivers should pay the full social costs of driving. If this happens, then we are indifferent to how much driving occurs.

¹² (Kahn and Kotchen 2010).

creates tension between preferred solutions for transport poverty and solutions to problems that automobility causes.

People have different priorities that affect interventions they will support. For instance, for some people carbon emissions and climate change are the biggest problems associated with transport, and they feel that all policies should focus on reducing emissions. But how to reconcile this preference with improving equitable access? The US is car dependent. People who do not have cars are then, by definition, disadvantaged. To improve their advantage we should expand auto access, which can come in many forms, but doing so will harm environmental policy, cause more congestion and other externalities, and may take away some transit riders when transit can scarcely afford to lose any. So, we need to balance the needs of some people today with the desires of some people in the future. This is not easy.

Pretexts of Safety and Justice



Figure 22.1: Shoes and a gun on the ground outside Philando Castile's blood-stained car as Minnesota Bureau of Criminal Apprehension (BCA) investigators take photographs of the scene of where a St. Anthony Police officer shot and killed 32-year-old Philando Castile in a car near Larpenteur Avenue and Fry Street in Falcon Heights, Minnesota, on July 6, 2016. Photo by Tony Webster. Source: Wikipedia.

American cities are substantially shaped by race relations. Discriminatory policies have been widely acknowledged in housing policy. Redlining practices, mortgage insurance, and local zoning codes discouraged multifamily housing while simultaneously making single family housing the default option in most cities.¹ Racial discrimination has been less central to transport policy, though this is more by oversight rather than wokeness.

Transport in the US strongly affects civil rights. Rosa Parks started her protest on a bus. Recent Black Lives Matter protests have shut down roads and freeways as a deliberate strategy to argue their point.² The use of fines and fees from traffic citations has turned minor offences into life-altering jail terms.³ Communities of color have higher rates of pedestrian deaths by automobile than white communities.⁴ The transport planning system reinforces these and other longstanding racial biases. None

¹ (Rothstein 2017).

² (Badger 2016).

³ (Shapiro 2015).

⁴ (Cottrill and Thakuriah 2010).

of this can be fixed easily, but ignoring the issues associated with policing and transport exacerbates existing problems.

By far, the most common interaction people have with the police is traffic stops. About 9% of American adults are pulled over annually.⁵ Due to the local nature of policing, this varies by state and city. Men are more likely to be pulled over than women, which suggests men drive more lawlessly. Yet Black and Hispanic drivers are more likely to be stopped than white drivers, and there is little reason to think there are racial differences in driving behavior. If anything, since Black and Hispanic drivers know they are more likely to be stopped, we might posit they will be better drivers to minimize risk from police stops.

What we should take from all of this is that transport policies, including calls for greater traffic enforcement, have racial implications, and we are wrong if we ignore them. Promoting accessibility means promoting access for everyone, regardless of their personal characteristics. Too often concerns about equity and social justice are discussed as a nice ideal that can be achieved through painless policies. The truth is more complicated in that to solve problems of racial equity in transport requires better policies and a broad agreement that a problem exists. We have work to do on both policy and education.

22.1 *Safe streets for all*

As we talk about accessibility, we make an implicit assumption about safety. Namely, we assume that by promoting access by multiple modes we aren't putting people in danger. Walking in your community shouldn't come with risk of death. Yet, this is the case for many low-income communities. These areas tend to have more biking and walking than wealthier communities, but this is more by circumstance rather than choice. More active travel, while a desirable planning goal, is risky when it is done on high-speed arterial roads with few crosswalks and poorly maintained sidewalks. Income is not the only factor, either, as pedestrian death rates are higher in African American and Hispanic communities as well.⁶

⁵ (Langton and Durose 2013).

⁶ (National Complete Streets Association 2017).

In many ways, accessibility explains why some communities are more dangerous than others. In the case of pedestrian deaths, accessibility for autos diminishes accessibility by other modes, which in turn makes these areas less desirable for development and re-development. Through this cycle low-access places become even less desirable communities to live in as they are filled with cars

driven at high speeds, polluting the air and making noise – automobility is a disamenity to neighbors. This imposes downward pressure on housing prices, so lower income people move into housing they can afford, but often without safe alternatives to driving. This is a vicious cycle.

Auto-oriented neighborhoods are demonstrably worse for people who walk or bike. Not only are drivers less likely to yield and let a person cross a street when driving fast, but drivers are less likely to yield to non-white individuals.⁷ Even worse, justice is often perverted to blame the victims who are hit. In 2011 Raquel Nelson was crossing an Atlanta area arterial with her three children in order to catch a bus.⁸ There wasn't a crosswalk near the stop. Her four-year old son was hit and killed by a drunk driver. She was charged with vehicular homicide – not the driver. This sad story is made marginally better as the charges against her were reduced to jaywalking and a \$200 fine. Her son was still dead.

⁷ (Goddard et al. 2015; Coughenour et al. 2017; Schneider et al. 2018).

⁸ (Schmitt 2013).

Issues like these are both design concerns, but mostly reflect prioritization of mobility over accessibility. No one would suggest that bus stops should be placed in areas where it is deadly to cross the street. Yet we do this very thing, and it is usually communities of color that suffer the consequences.

22.2 *Racial bias in traffic enforcement*

Few things are as identified with being an American as driving. 'Driving is freedom,' as the saying goes, and most able adult Americans drive themselves most places they need to go. The car and the open road are part of an American identity, for better or worse. Another identity in the United States is of African Americans. Being black in America is to experience the country in ways that are different from the experiences of any other racial or ethnic group. In *Pulled Over*,⁹ the authors describe driving as a required condition of citizenship and equality in a modern democracy. Because of this, they argue, traffic enforcement – even if seemingly modest requests for identification or insurance – strikes “at the heart of democratic citizenship and racial equity.” Automobility is required for economic and personal freedom.

⁹ (Epp et al. 2014) (p.17).

The conception of automobility as a prerequisite for full participation in democratic society strikes many planners as wrong. Cities should be built to provide access to all, regardless of how they travel. In the abstract, this is a fine sentiment. Cities should not be built so that people have to drive everywhere. But a normative view of how cities *should* be must be balanced by a positive

recognition of how cities *are now*, and at present most cities are auto-dominated and driving remains aspirational for many people.

Attitudes about city services are also affected by race and ethnicity. White residents consistently have higher opinions of municipal services than African American, Latino, or Asian residents. Policing, in particular, stands out for racial differences. A nationwide survey estimated that share of African-American respondent satisfaction with police services is more than 20% below the share of white respondents who were satisfied.¹⁰

¹⁰ (Hajnal and Trounstein 2014a;b).

¹¹ (Baumgartner et al. 2018).

In *Suspect Citizens*¹¹ the authors trace the history of traffic stops from the advent of ‘reasonable suspicion’ as the standard for police intervention after the *Terry v. Ohio* Supreme Court decision in 1968. Prior, police needed probable cause to intervene. This legal change opened the door for the United States’ ‘War on Drugs’ to become a very large traffic sting. There was so much pressure to find drugs, and the likelihood of finding any was so small, traffic enforcement became a volume business that continues to this day. A recent *Los Angeles Times* investigation found that police targeted a section of freeway north of Los Angeles for drug busts, and stopped over 9,000 drivers between 2012 and the end of 2017. Seventy percent of drivers were Latino, and three-quarters of the Latino drivers pulled over had their cars searched despite no evidence that Latinos violate drug laws any more than any other group.¹²

¹² (Rubin and Poston 2018).

Traffic enforcement is not a straightforward public service. While traffic laws such as speed limits and obeying traffic signals are clear, enforcement is determined in many ways by factors independent of any infractions. Enforcement often features spatial differences, where neighborhoods that are similar in most ways will differ greatly in traffic enforcement activities. These differences may be explained by the presence of a school for instance, or a poorly designed intersection that leads to a high rate of crashes. Socio-economic factors also play into enforcement activities.

Cities with higher proportions of African American have greater reliance on fines and fees than otherwise similar cities. A recent examination of 9,000 municipalities in the United States showed that the share of minority population is positively associated with the use of fines and fees.¹³ These fines and fees are not exclusively from traffic enforcement, but traffic is a major component. One reason traffic enforcement is so popular as a revenue source is due to local control of law enforcement. Cities can set fines as they wish, though in some cases they have arrangements with the state to share any revenues. New York City, for instance, shares 50 percent of revenue collected from moving violations with the state, but keeps 100% of

¹³ (Sances and You 2017).

parking enforcement revenues. This is the reason parking is enforced more zealously than moving violations.¹⁴ Traffic enforcement is putatively for safety. Unfortunately, this public safety goal is tainted by revenue goals. Abusing safety-granted powers for revenue or harassment of minorities is wrong.

¹⁴ (Hinds 2013).

22.3 *US police interactions are needlessly violent*

On July 6, 2016 a City of St. Anthony police officer shot and killed Philando Castile following a traffic stop in the Saint Paul suburb of Falcon Heights, the aftermath was filmed by his girlfriend Diamond Reynolds. We have both been past the site, next to the Minnesota State Fairgrounds, hundreds of times.

It has never been a problematic area or considered a dangerous neighborhood.

Recent shootings are catalogued at *The Counted*.¹⁵ Police in the US shoot and kill about 1,000 people per year. We have no good data from more than a few years ago, and there is no requirement that the more than 18,000 police departments in the country report shootings to the FBI. Many begin with traffic stops and moving vehicle violations of one form or another. In this case, Castile was driving and pulled over for a broken light. He certainly knew the drill – he had been stopped by police 46 times in the 13 years he was a licensed driver.¹⁶

¹⁵ *The Counted* by *The Guardian*, counted police-involved deaths in 2015 and 2016. The US Bureau of Justice Statistics decided to track this in 2017, so the *Guardian* stopped.

Cars (and their drivers) kill about 40,000 people a year in the US (and have risen in recent years) and 1.25 million globally. This is terrible. The US has the highest rate among high-income countries. It justifies many things, including engineering safer roads, educating better drivers at the initial training and licensing stage and ongoing continuing education programs, designing better vehicles and especially automated cars, reduction in drunk driving, and increased enforcement.

¹⁶ (Peralta and Corley 2016).

But does enforcement, which is ostensibly about safety, require armed police officers pulling over men of color at a disproportionate rate because one tail light is out, and shooting them? Is this ‘enforcement’ really about traffic safety? Or rather, is this just another way for municipalities to raise money in fines for minor violations, as was done in Ferguson, Missouri, or discourage people ‘who don’t belong’ from traveling on the quiet streets of someone else’s neighborhood.

Transit systems are not without police bias, as well. In 2009, Oscar Grant, an African American, was killed by Bay Area Rapid Transit police officers who shot him in the back while obeying their

¹⁷ The events of Oscar Grant's killing were the basis of the 2013 film *Fruitvale Station*.

¹⁸ (Lee 2017).

¹⁹ (Schmitt 2017).

orders. Though the officer who shot Grant was found guilty of involuntary manslaughter, he was acquitted of more serious murder charges. This verdict, and the shooting itself, led to days of protests that sometimes turned to riots in Oakland.¹⁷ Many transit agencies enforce fare payment with the zealotry of national security. In most places, fare evasion is criminal offense that carries substantial financial penalties and time in jail. Enforcement also disproportionately affects African American riders. Fare evasion enforcement has also led to deportation in at least one case.¹⁸ Fortunately, many cities and states are starting to decriminalize fare evasion to make it a civil offense.¹⁹ Reducing the severity of the offense is good, but enforcement is still conducted by armed officers.

Looking at *The Counted*, about 1/3 of police killings were transport related. Certainly most of the killed were violent, and committed serious traffic violations, or otherwise engaged in illegal activities or fleeing the scene of a crime. If you want to give the police the benefit of the doubt, perhaps killing them was the only way to subdue them and keep them from immediately harming others. Yet somehow other countries don't seem to have this problem in such numbers, why is that?

Poorly trained police in the heat of the moment afraid of people who look different and armed with deadly force will sometimes make mistakes that they regret. But why are they in that situation to begin with? Why are they poorly trained? Why are they afraid of 'the other'? Why are they using a gun on someone nominally pulled over for a broken tail light rather than backing off a bit, photographing the car and recording the license plate, calling for help and trying to safely get control of the situation?

22.4 *Why is traffic safety used as a pretext?*

Traffic rules and regulations are the pretext for enforcing the crime of 'Driving While Black.' This is not to say there is no use for traffic enforcement, even though evidence is mixed as to its effectiveness.²⁰ We can stipulate real enforcement probably does not reduce traffic safety. So long as there are humans driving cars, there will be humans driving cars badly. Automatic surveillance has successfully reduced much bad behavior like speeding and red-light running. This can be done systematically, and not randomly, and thereby both avoid bias and be more effective.

Yet think of what many of the actual stops are for. Not speeding or moving violations, but for vehicles out-of-perfect-order. The broken

²⁰ An alternative to greater enforcement is better design.

tail light is illustrative. How many lives have been saved by traffic stops who informed the drivers of vehicles that one of their brake lights is out? We could not find a peer-reviewed article on whether broken tail light enforcement is effective in increasing safety. No one has felt it worthy of study in the traffic safety community. The broken tail light does show up as an issue of pretext, the legally protected excuse law enforcement gives to pull someone over because they want to inspect the vehicle or the occupants.

Clearly we want cars with working tail lights. Minnesota law requires two working stop lights for cars manufactured after 1960 (but not for motorcycles).²¹ But this is also not a high priority.

If we actually cared about tail lights, there is an alternative scenario. Police (or better a machine) could have just photographed the car and mailed a fine to the address on record of the owner of the car, which would hold up annual registration if not paid and if no proof of repair provided. The car would eventually get fixed.

Instead, we have the scenario, which if it had gone well, finds the driver (not necessarily the owner) getting a stern lecture and a fine. There is no actual guarantee of the repair.

But if we cared about traffic safety, the time and resources the police spend on harassing vehicles with broken tail lights could be spent on something more serious: actual drunk drivers, actual speeders, actual red-light runners. The evidence argues these stops are not about traffic safety.

²¹ Minnesota Statute 169.57 Vehicle Signals. Available through the Minnesota Office of the Revisor of Statutes.

22.5 *Not in our name*

Everyone involved in the transport professions should say “Not in our name.”

Everyone who advocates for traffic safety should say “Not in our name.”

Everyone who plans roads, sidewalks, and neighborhoods should say “Not in our name.”

We in the transport community need to advocate for measures that truly improve traffic safety, and advocate against slippery measures that are used as pretext for racism or drug war enforcement or municipal fund-raising.

Part V

Conclusions

In our conclusions, we call for rethinking how we build and operate transport systems to promote access for all.

Jam Today, Access Tomorrow, or Six Impossible Things Before Breakfast

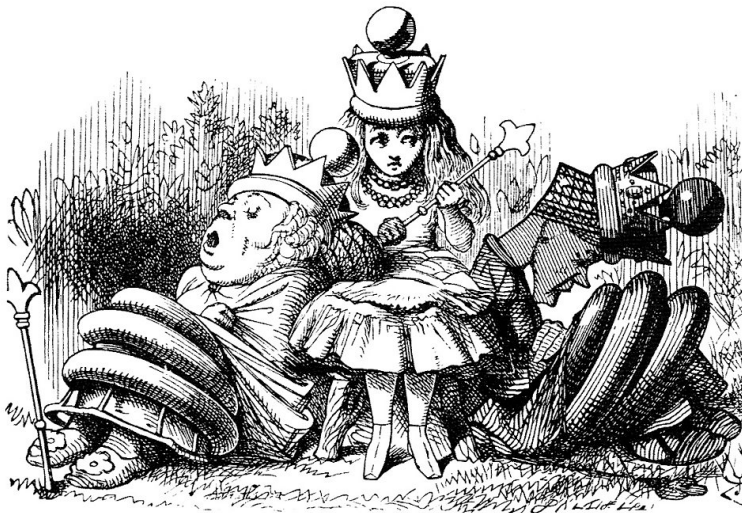


Figure 23.1: Alice with the Red and White Queens. From *Through the Looking Glass*. Drawing by John Tenniel. Story by (Carroll 1917).

Throughout this book we have described the political challenges permeating our transport and land use systems. While politics gets messy, our arguments are straightforward. We need to prioritize accessibility over mobility, preserve what we have before we expand, and reform our institutions so that their incentives are aligned with broader economic and environmental goals. Mobility, expansion and current institutions are all political decisions and they can be changed. We have chosen, albeit slowly and passively, to build our cities the way they are. We can do better, but only if we change our focus to what matters.

¹ (Levinson and Krizek 2005).

INCREASING ACCESSIBILITY IS MORE IMPORTANT THAN REDUCING CONGESTION. Accessibility describes how well the transport and land use system work together. It is why cities and networks exist, they are both ‘machines for access.’¹ Considering mobility or congestion alone (how quickly one can move on the transport network) would lead the unsuspecting reader to conclude the system was getting worse. However, examining mobility in addition to land use changes demonstrates that people can reach more activities in the same time, despite the historical increases in congestion.

Accessibility as an idea is much deeper than just a performance indicator. As a measure of benefit, it suggests a path for reforming local transport finance to better connect benefits with costs. If costs of transport (the transport share of local taxes) were more proportional to the benefits, both efficiency and equity would improve.

Accessibility considers both travel time and the number of opportunities, which gives a fuller understanding of travel, cities, and policy approaches. Congestion can be reduced in any number of ways. One way to do so is through an economic recession.² Congestion clearly is not a good performance metric for cities; while the ability to move on roads has improved with fewer travelers, the number of places to go to (and the resources available to spend there) have both declined. Passenger travel is still largely a derived demand, so we should be careful about thinking we’ve solved congestion when larger economic problems may be in play.

² For instance, congestion declined and travel speeds increased substantially during the Great Recession. The decline in VMT starting in 2004 that led many to call ‘peak car’ was largely explained through economic factors (Manville et al. 2017), though per capita auto use has still not reached its early 2000s peak in the North America, Western Europe, or Australia.

INFRASTRUCTURE PRESERVATION GIVES MORE ACCESS PER DOLLAR THAN SYSTEM EXPANSION. Through this book, we argue maintaining existing networks is more important than constructing new networks. In the near term, we should redirect existing federal (and state) gas taxes to address the problem of aging infrastructure. We identified the federal problem as preserving the National Highway System. There are gas taxes already spent to some extent on this problem, but gas taxes (highway road user fees) are also spent on new projects, and for transit projects, neither of which rise to same level of national justification.³ It is clear with electrification, and without increases in the federal gas tax, that existing revenue sources are beginning to fail.

³ Identifying the amount spent on transit is easy. Disentangling highway capacity expansion from preservation is tricky, since many reconstruction projects wisely bundle both to achieve efficiencies.

There are insufficient revenues to properly maintain the system, a problem that will be exacerbated over time without a directed solution. From a ‘technical’ perspective, this is easily resolved:

- Pay for local roads with highway user fees. Currently local road funding is dominated by general revenue (property tax). There

is no reason these roads cannot be paid for with user fees, most simply today a state-level gas tax returned to local governments.

- Internalize the costs of various environmental externalities so that roads are not being implicitly subsidized by everyone who experiences the externalities they cause. Charge roads (and their users) directly for noise, air pollution, water pollution, and carbon emissions, and any other measurable effect on which we can objectively place a price tag. This does not generate revenue for roads, but does lower demand and thus infrastructure costs. These externalities are a cost to society, borne by the health, insurance, and real estate sectors among others.
- Charge the general sales tax on gasoline and other transportation inputs, on top of road user fees, for general revenue. This will put roads and cars on a more even basis with other goods, and avoid hidden subsidies. Similarly, charge roads for the land that they use, and charge annual property tax on that land. Again, this does not raise funds for roads, but by making road users pay their share, decreases demand
- Raise and index the gas tax in the short-term to establish a baseline of user-based revenue that coincides with expenditures required to preserve the existing system.
- Phase in the a mileage tax in lieu of the gas tax starting with electric vehicles (EVs), which don't pay gas taxes, and autonomous vehicles (AVs) which risk Robin Chase's 'hellish' scenario of unoccupied vehicles circling the block to avoid paying for parking.⁴ EVs are still few in number, AVs fewer still, but they are, and will be for some time, disproportionately owned by the rich. One day soon they will be commonplace and the gas tax revenue will really go to zero.
- Phase in time-of-day pricing, initially as an opt-in discount for vehicles paying by the mile. This has the merit of both raising funds from the users who place the greatest stress on the system, and lowering demand during peak times.
- Implement a weight-distance tax for trucks. This both raises funds and encourages truckers to more efficiently manage their fleet considering infrastructure costs they impose.

⁴ (Chase 2014).

From a 'political' perspective this is more difficult.

NETWORK EXPANSION SHOULD BE PAID FOR BY PROJECT BENEFICIARIES. Why shouldn't the federal government focus on

expansion of the system? The short answer is it long ago picked the low-hanging fruit and built the best routes, around which we have built our existing communities. Ensuring that the existing National Highway System remains functional offers a far greater return on investment than expanding it with new routes serving land speculators or widening roads serving local traffic, at a time when new technologies such as self-driving cars are on the verge of significantly increasing roadway efficiency. New projects generally have lower benefit/cost ratios (if even above 1.0) than maintaining existing roads. Infrastructure maintenance is expensive, but it lasts for many years. It is important to make the wisest choices about where to spend scarce dollars.

In addition to narrowing the federal government's role to preserving the existing network rather than expanding it, policymakers should empower localities to make their own choices about how to spend those maintenance dollars. Highway Block Grants would return highway user funds collected in states and localities to those areas so they would have the freedom to make their own decisions about where to invest in the preservation and maintenance of the National Highway System. After all, policymakers in the states and localities better know the conditions and needs in their areas than do remote administrators in Washington.

Transit capital projects are seldom of an interstate nature, and federal funding currently distorts transit decision-making by making it very capital intensive. Further transit projects are currently funded by road users rather than by transit users (or the general population). People engage in magical thinking about transport modes, we believe public policy would be better served by rigorous analysis, and that would demonstrate that projects cost too much, they benefit too little, and the costs are now borne by non-beneficiaries. If prospective beneficiaries had to finance what they hope to benefit from, there would be better management and oversight of projects, from the local governments and private firms with skin in the game.

To that end, there are a number of specific solutions:

- Use a combination of tolls and various types of value capture to pay for the large capital costs associated with any new infrastructure. If the project cannot be financed from either users or direct non-user beneficiaries, it cannot be justified on economic grounds.

- Build and expand fewer roads. Demands are dropping already with peak travel, and will do more so once congestion pricing is implemented. Most roads are underused most of the time, so load balancing is better strategy than new construction. Make those roads smaller when they are built.
- Reduce the size of the mobility-focused network (gravelization, freeway abandonments, reallocation of road space to transit and bike lanes where appropriate, etc.). Smaller networks promote access through more efficient use of scarce space and improved proximity of opportunities.
- Reduce operating costs by replacing active management with passive or self-managing systems. For instance, we can replace traffic lights with roundabouts in many locations,⁵ and deploy shared spaces more widely.
- Given continued public allocation of transport funds at the local, state, and federal levels, funding should reward projects that measurably, objectively, and cost-effectively increase accessibility, rather than those that reduce congestion or solely focus on mobility. Projects can be ranked based on units of accessibility (for instance, the increase in the number of person-weighted jobs within 30 minutes in the AM peak hour per dollar spent), with only the best projects supported.

⁵Though we cannot put roundabouts at over-saturated urban intersections or where there are space constraints.

CITIES ARE ORGANICALLY EVOLVED 'MACHINES FOR ACCESS'. Cities, counties, metropolitan areas, and states have a number of strategies to increase accessibility. Reducing congestion on existing roads, and expanding transport capacity is one of a family of strategies. In this regard, removing or mitigating transport bottlenecks, and adding (or restoring) missing links to networks are among the most promising strategies. Using existing road space more efficiently can provide significant capacity. This includes strategies like ramp metering, widely deployed in some cities, to lane speed management and policies to discourage lane changing, deployed now in a few places, to narrowing lanes and conversion of shoulders to travel lanes (as on I-94 in Minneapolis in response to the I-35W bridge collapse). There are many low-cost strategies available with existing technology that can make significant differences. One of the great untold stories of the construction of the Interstate Highway System, which invaluablely expanded long distance accessibility, is how it tore asunder local neighborhoods⁶ and reduced local accessibility (especially important for non-work trips) by disconnecting local streets, reducing network redundancy,

⁶ (Altshuler 1966).

⁷ (King et al. 2008).

⁸ In December 2018 Minneapolis passed a comprehensive plan that abolished single family zoning and eliminated parking requirements for new construction. This should lead to more duplexes and triplexes throughout the city, thus creating more 'missing middle' housing and promoting access. Creating density does not have to mean large apartment buildings.

and overall made the local network more tree-like and less web-like. This can be reversed at least in part with land bridges and more local road crossings.⁷

Land use strategies that encourage and reinforce natural market tendencies to co-locate jobs and housing is another.⁸ Providing incentives (or removing barriers) to locating residences in job-rich areas, and job-sites in housing-rich areas would improve overall accessibility. Similarly, developing land at transport nodes more intensively could also increase transport network efficiency. The effectiveness of many recent rail systems is diminished by local zoning that restricts development density at stations. As these are among the most expensive transport facilities, it is most important to correctly coordinate the transport and land use here. Traditionally, regulations on land use are designed to diminish negative externalities like congestion and pollution in the absence of good pricing. With proper pricing, land use regulations can be relaxed to foster access.

EXISTING INSTITUTIONS DON'T LET US IMPLEMENT OUR PREFERRED POLICIES. When the United States last significantly overhauled federal surface-transport policy in 1991, Americans who wanted to travel to an unfamiliar location used paper maps, usually purchased from a bookstore or gas station. If they were on a toll road, they stopped at the tollbooths and rolled down the window. They listened to an AM/FM radio, a cassette tape, or maybe, if they had a new car, a compact disc. The car of the future was equipped with a fax machine. The Internet, smart phones, and texting were essentially unknown. The nascent Global Positioning System was incomplete, and its use was limited to the military.

Today, Americans use GPS apps with crowdsourced traffic data not only to help them navigate but also to alert them of hazards and reroute them to avoid congestion. They use radio transponders to pay as they drive through toll plazas without slowing down. And they might subscribe to satellite radio, use a predictive streaming service such as Spotify to listen to music, or subscribe to podcasts that cater to their specific tastes. Electric vehicles have moved from fringe to the forefront of automotive technology. There are even a few self-driving cars on the road.

And yet, despite all these innovations and advances, America's transport policy remains blissfully mired in the 20th century with road maps and cassettes. Every day, urban commuters confront congestion and an aging infrastructure whose deterioration outpaces its repair. The causes of these problems, however, are not

as obvious to drivers, including structural issues with transport funding and financing (who pays and how much), the insufficient and outdated management system that oversees our patchwork road system, and the propagation of unnecessary transport projects, including infamous bridges and roads to 'nowhere' serving special interests.

Institutions are broken, so what we believe to be the sensible policies advocated above are not politically feasible at the moment. Moving towards a utility model would help. The political governance needs to be resolved before funding is. Establishing an independent, regulated, and publicly-owned or cooperative 'road utility' (or several of them, at different levels of the road hierarchy, and/or for different geographical regions) is a strategy to successfully implement pricing. It deals with both privacy and institutional structures and provides the rationale and cover for funding increases to maintain existing infrastructure (and perhaps expand it).

A large part of the problem is its political nature. We would not tolerate in the US periodic blackouts from an electric utility because they could not manage supply and demand. In fact this was the what in large part led to the downfall of Governor Gray Davis of California and the political rise of Arnold Schwarzenegger. Why do we tolerate the transport equivalent, congested roads and unreliable transit? Because roads and transit are owned and operated by governments. If they were separate (and regulated) organizations, not directly responsible to the state legislature, we might have different outcomes. The notions of 'free' and 'already paid for' and 'double-taxation' that are used to politically defeat tolling proposals would be replaced with a 'fee for service' concept common in public utilities. A model of 'institutions loosely coupled,' each with specific missions, management, and revenue would outperform a giant monolithic government that tries to do everything for everyone, yet nothing very well for anyone.

The key points in reformulating the institutional structure are listed below:

- Move the administration of transport to an independent publicly regulated utility.
- Depoliticize road management decisions by taking road operations out of the hands of the Executive Branch so that decisions are made on technical rather than political grounds.⁹
- Depoliticize road pricing and taxing decisions by taking them out of the hands of the Legislative Branch and are instead put them

⁹Investments in new routes and rights-of-way remain political in their very nature.

in the hands of an objective, less political Public Utility Commission, so that decisions are made on technical rather than political grounds.

- Reduce the number of layers of government: Treat road services as end-to-end systems (including local and long distance routes) managed by a single organization that can attain and exploit economies of scale.

THE WISDOM OF THE WHITE QUEEN. The Red Queen from Lewis Carroll's *Through the Looking Glass* noted:

Now, here, you see, it takes all the running you can do, to keep in the same place.¹⁰

¹⁰ Carroll (1917).

This gives rise to the evolutionary (Red Queen) hypothesis that organisms must constantly adapt to survive in a continuously changing environment with evolving opposing organisms. In technology history, technologies take the place of species, and while we get progress in technology, all other technologies and behaviors adapt. We may expand a road, but find the capacity is used up by more cars traveling longer distances. We may reduce crash risk with a new safety feature, and find it gets used up by more dangerous driving.

The White Queen, the Red Queen's sister, says that in her youth:

Why sometimes I've believed six impossible things before breakfast

and counsels Alice to practice the same skill. While believing impossible things may seem *quixotic*, to borrow from a different piece of fantastical fiction, we think it is also necessary to improve the world.

Following the learned advice of the White Queen, we believe several impossible things:

- Access should replace congestion as the measure of transport.
- To maximize access per dollar, the decidedly sexy maintenance and preservation of already operating networks should be the focus of transport system operators, rather than ribbon-cuttings and expansion. We like Jane Jacobs' notion of 'ribbon-tyings' to preserve things.
- Travelers should pay for the full cost of the roads and services they use, including the externalities they create.
- Zoning can be eliminated if we properly price externalities. At the very least, zoning should expire after a period of a few years,

thus forcing a new political discussion of its merits periodically. Zoning codes in the US are largely based on mid-20th century industrial and social concerns. Industry is generally less noxious at this point thanks to clean air and water regulations, and the social norms of the 1950s are not something we should preserve.

- The planning horizon for transport projects should be reduced. Currently, transport planning is long-term, where cities, MPOs and DOTs plan for 25 years. This time horizon is required by law in most cases. But in an era of technological change and pressing social and environmental concerns, 25 years is too long. Transport and land use policies need to be more nimble and adaptable to changing conditions. The long-range nature of transport planning has not obviously improved outcomes. In fact, an argument can be made that we simply extended the duration of projects to meet long-range requirements rather than increase the number or scale of projects we accomplish over a few decades. Consider that the Interstate system was largely completed in 20 years while California's single high speed rail line will take a minimum of 25 years from when the voters approved it to fully opening (if it ever gets completed).

We conclude these things are effectively impossible in today's world, as evidenced by their non-existence, despite decades of policy analysis saying they should be so. They are impossible because the current configuration of institutions does not permit them. While we cannot expect politicians, who, like everyone, consider themselves experts, to take courageous long-term decisions to raise taxes on road users, it is perfectly acceptable for a public utility to recover costs and patch systems rather than be beholden to the sexy new piece of infrastructure. Changing institutions is not without its own political challenges, but may be far less difficult than asking for a fare or toll increase in every election year.

An optimistic take, and we are optimists though we often sound come across like wet blankets thrown on the latest hype cycle, is that the real challenge is change itself. There is a strong status quo bias in policy. People like what they have even if they don't like what it does. Congestion pricing has proven most unpopular just before implementation, but after it is put in place people tend to like it.¹¹ For many in the transport and land use fields, the unknown outcomes of major institutional change are too risky, even though without such change we will never achieve the outcomes we want and need. If what we are doing doesn't work, then the solution is not to simply do more and more of it. A

¹¹ (Börjesson et al. 2012).

mobility-focused system will fail at promoting access. Our mobility-focused system is a product of, and reinforces, existing political incentives and institutional structures. We must change the politics to change the policies.

¹² (Carroll 1917).

The White Queen in *Alice in Wonderland* also promised “Jam To-morrow,” and “Jam Yesterday,” but “never Jam Today.”¹² In traffic, we don’t want jams, we want access. Congestion, and its reciprocal, mobility, have far too long been the dominant measure of transport. We argue in this and other works that we should focus on accessibility, the ease of reaching valuable destinations, rather than just mobility, or the speed of movement on the network, in assessing transport and land use decisions. We want “Access today” and “Access tomorrow,” and should have wanted “Access yesterday,” if we had thought clearly about it.

We titled this book *A Political Economy of Access* to denote that many of the problems we face to ensure access are policy issues governed by politics. Getting the institutions right can make the impossible possible.

Appendices

A

A Goods Framework

	Excludable	Non-Excludable
Rival	Private (Market)	Congesting (or Common Pool Resource)
Non-Rival	Club (Utility, City)	Public

Figure A.1: Types of Goods.

Many things are important and essential that are largely done by the private sector. Many things are neither important nor essential are done by the public sector. In transport, the words ‘public’ and ‘private’ are used in ways – such as ‘public’ transport to mean mass transit¹ – that obscure these characteristics. Just because something is publicly supplied doesn’t make it a public good. What differentiates between which sector a good or service is provided is not essentialness, nor its importance, but rather its excludability and its rivalry.

A good is excludable if the provider can charge for it and prevent use without payment. A good is rivalrous if my consumption prevents yours. These definitions sound clear, but in practice are highly contingent on context. A good may be effectively rivalrous at the margin when there is heavy demand, but not on average, when demand is light. A good may be excludable in theory, but the transaction costs of implementing excludability are not worth the effort in some circumstances, but are in others.

This appendix explores and extends that idea, and applies it to roads and transit.²

¹ The British use the term ‘public’ school to mean private school, as another example of conflation of terminology.

² What is termed ‘transit’ or ‘mass transit’ in the United States is often called ‘public transport’ elsewhere. To avoid confusion, we will use the term transit in this chapter to refer to a mode which moves multiple parties.

A.1 Rivalry and excludability

As illustrated in Figure A.1 Goods that are both excludable and rivalrous are classified by economists as *private* goods, and are often provided by the private sector. Food is both important and essential, yet most Americans get food from private vendors in the US, ranging from the local farmer's market to the largest Big Box store.

In contrast, goods that are neither excludable nor rivalrous are categorized as *public* goods. The classic example is national defense, which serves all members of the public whether they want it or not, and which is paid for with taxes. We can't just 'not subscribe' to national defense. No private firm provides a nuclear defense in case one's property is invaded by a foreign army. Another example is public street lighting, which benefits all road users (often to the annoyance of the neighbors).³

³ (Marques and Geddes 2018).

We can of course debate the amount of public good we want. Over-the-air broadcasting is also a public good, though it is privately provided.⁴ Anyone with a receiver can get any over-the-air channel. In that case, broadcasting is funded not by taxes but by advertising.⁵ The model is switched and the viewer is the good being sold to the advertiser, since the market for advertising on over-the-air television is both excludable and rivalrous (since time is rivalrous and broadcasters can sell it to whomever they like for the market rate).

⁴ It is possible to broadcast in coded signals that require special devices to unscramble, but this is an exception.

⁵ The UK, for instance, uses taxes to pay for the BBC, and in the US, mostly commercial-free PBS receives limited public support, so this model varies.

Yet very few things are purely private or purely public, which provides little guidance for policy. In what follows we focus on other types of goods that better fit with experience.

Goods that are excludable but not rivalrous are called *club* goods. Many public utilities (those with adequate capacity for potential demand) fall into this category.

Goods that are rivalrous but not excludable are called *congesting* or *common pool resources*. Most transport falls into these categories.

A.2 Goods and roads

These cases are illustrated below by visiting the main layers in the hierarchy of roads. Figure A.2 idealizes a map of an area illustrating different layers of the hierarchy, and how they interact. The freeway is at the top of the hierarchy, there are major arterials which have freeway interchanges. They themselves intersect other major arterials and minor arterials. The minor arterials connect to neighborhood distributor roads, and those connect to neighborhood

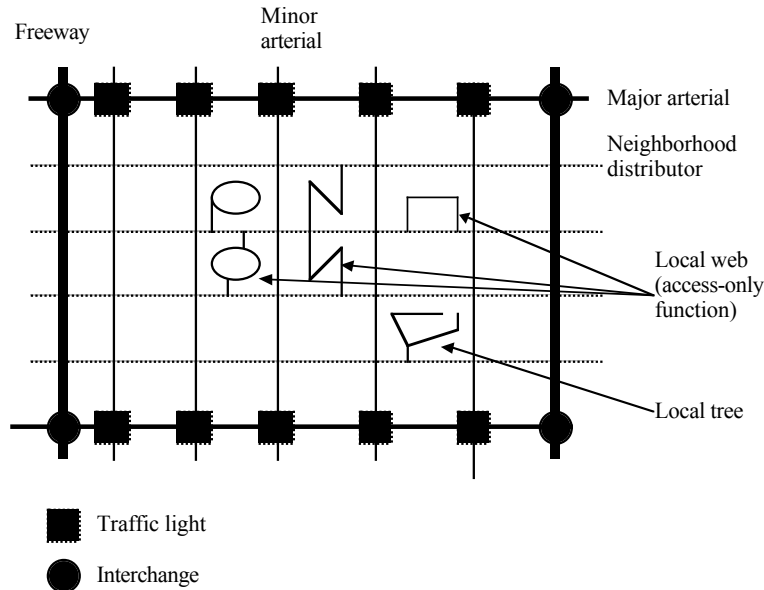


Figure A.2: Network with topological classifications. Source: Figure 5.2 (Levinson 2002).

traffic collectors. At the bottom of the hierarchy, roads may be arranged like a tree, and not inter-connect.

LOCAL ROADS – EXCLUDABLE, BUT NOT RIVALROUS (CLUB GOODS). At the local level,⁶ roads are clearly natural monopolies, as local streets have high fixed costs and low costs per use, and in most cases it does not make sense to have your house served by two competing roads (just as you have only one electric utility, one water utility, one natural gas utility, and so on). Many older places have alleys or laneways serving properties from the back in addition to the street serving from the front. One could conceive of them being competitive. Newer developments tend to avoid construction of this duplicative infrastructure.

Local streets have been privatized in some places, such as streets and driveways managed by the local homeowners association, and another example are the private street associations in cities like Saint Louis,⁷ but these ‘private road associations’ are basically monopolies or clubs, and are not competitive, and could be thought of as the most local level of government. This can lead to unforeseen issues. San Francisco’s Presidio Terrace, a private road that had been owned by the homeowners association, was sold at auction in 2017 because the neighborhood inadvertently failed to pay property taxes on it. The new owners were thinking of ways to

⁶ Local streets are sometimes called ‘the last mile’ or ‘the first mile’, depending on your perspective.

⁷ (Foldvary 2006).

Figure A.3: Functional Classification

	Types of Connections	Relation to Abutting Property
Limited Access (highway)	Through traffic movement between cities and across cities	Controlled access highways with ramps and/or curb cut controls
Linking (arterial: principal and minor)	Traffic movement between limited access and local streets	Direct access to abutting property
Local (collector and distributor road)	Traffic movement in residential areas	Direct access to abutting property

⁸ (Wong 2017).

profit from it, including charging residents for parking, but the San Francisco Board of Supervisors reversed the sale.⁸

LIMITED-ACCESS ROADS – EXCLUDABLE AND RIVALROUS (PRIVATE GOODS). A limited-access highway is, by definition, limited in the number of access points. Each of these can be controlled, either by ramp meters or by toll gates. The evidence for this is that many of them are. This is cost effective so long as the revenue collected from the tolls exceeds the cost of collection, and can at least in part defray the cost of building, operating, and maintaining the road.

In fact these limited-access roads are private in many places; private in the sense they are long-term concessions or franchises controlled by a private for-profit firm which has significant latitude in how the road is operated. These places include ‘Socialist’ France and China, but such private roads are rare in most of the ‘Capitalist’ US and UK.⁹ If these firms were competitive, on long trips, you might have a choice of suppliers for the line haul part of that journey if not the whole trip. They are competitive in that the concession or franchise agreement is contestable, other companies may enter the market, so the incumbent operator is not necessarily renewed.

⁹ A notable exception, and example of full privatization, is the Ambassador Bridge between Detroit, Michigan and Windsor, Ontario. <http://www.ambassadorbridge.com/>.

RURAL ROADS – NON-EXCLUDABLE, NON-RIVALROUS (PUBLIC GOODS). Rural roads don’t get congested generally, and so can be considered functionally non-rivalrous. They are also difficult to exclude traffic from because the costs of collection or enforcement would be high relative to the benefit. While they could be organized as a club good over a large enough area, if the area is large enough they might as well be considered public goods.

URBAN LINKING ROADS – NOT EXCLUDABLE, RIVALROUS (CONGESTING GOODS). The most complex level of the hierarchy of roads are those between local streets and limited-access highways. Often signalized arterials, their operations tend to be integrated. While one can conduct academic research thinking about the

implications of autonomous private links,¹⁰ it is harder to imagine that operationally. But it might be possible to privatize city streets collectively, or to have publicly owned streets managed by a private firm under contract.

¹⁰ (Zhang et al. 2008).

The section on [auctioning](#)¹¹ presents a thought experiment of traffic signals managed by private contractors with specific incentives, where green time is auctioned to create a cash flow. Implementing a congestion charge might be part of this.

¹¹ §18.4.

A.3 *Goods and transit*

As discussed above, economics defines four types of goods: public, private, congesting (or common pool resource), and club. Public goods are, by this definition, neither excludable (to use it, you must pay for it) nor rivalrous (the good is scarce and only one person can use it at a time). What type of good is mass transit?

URBAN PEAK HOUR TRANSIT – EXCLUDABLE AND RIVALROUS (PRIVATE GOODS). Mass transit is both excludable (at the cost of validating payment), and rivalrous (when congested). Under those conditions it satisfies the definition of a private good. Many private goods are privately provided, hence the name.

URBAN OFF-PEAK TRANSIT, RURAL TRANSIT – EXCLUDABLE, BUT NOT RIVALROUS (CLUB GOODS). When transport systems are designed to carry peak loads, they are under-capacity in the off-peak, and thus functionally non-rivalrous. We think this is the most common case in the United States

URBAN PEAK, FREE TRANSIT – NOT EXCLUDABLE, RIVALROUS (CONGESTING GOODS). Sometimes transit is operated non-excludably, for instance university campus shuttles, or an elevator in your nearest multi-story building. Similarly, sometimes transit operates with an honor system payment with lax (or no) enforcement. While they may be physically excludable in principle, the transaction costs of exclusion or enforcement don't outweigh the benefits.¹²

¹² Such as proof-of-payment through random inspections.

URBAN OFF-PEAK OR RURAL, FREE TRANSIT – NON-EXCLUDABLE, NON-RIVALROUS (PUBLIC GOODS). Often transit is not rivalrous, (non-rivalry implies my consumption does not affect yours, by increasing its cost or diminishing its quality) such as in off-peak times. The off-peak university campus shuttle is a public good in

Figure A.4: Types of Goods Extended.

	Excludable	Non-Excludable	Anti-Excludable
Rival	Private (Market)	Congesting (or Common Pool Resource)	Rally
Non-Rival	Club (Utility, City)	Public	Viral
Anti-Rival (Network)	Hub (Social Network)	Social Media	Memetic

¹³ Almost no one outside the university community would bother riding a free intra-campus university shuttle bus, so even if it is technically non-excludable, it is functionally excludable in that no one else would ride, and the people traveling on-campus have university business.

¹⁴ The term anti-rival is credited to Steven Weber. (Weber 2004).

¹⁵ (DeVries 2005).

practice. It is nevertheless paid for as a club good by the university and its students, since they are the primary beneficiaries.¹³

A.4 Anti-rivalry and anti-excludability

The opposites of *rival* and *excludable* are generally taken to be *non-rival* and *non-excludable*. Yet, that is incomplete. What is the opposite of one: zero or minus one? Hence the emergence of the ideas of *anti-rival*¹⁴ and *anti-excludable*. The concept of anti-excludability was first defined in a blog post by Pierre de Vries, ¹⁵ who writes:

These definitions, however, don't take into effect the network effects that have become so prevalent on the web. Social networks like Amazon reviews and del.icio.us tags are not just non-rivalrous, as one would expect from knowledge; the more one uses them, the more value is created.

These goods are 'anti-rivalrous.' Their use increases the amount available for consumption by others.

One can play the same game with exclusiveness. An 'anti-exclusive good' might be one where my giving it to you actively encourages you to pass it along to others. Viruses are one example; another is peer-to-peer software which someone cannot use without becoming a server node for others.

These terms are not widely used, but are useful to think about.

ANTI-RIVAL: I BENEFIT IF OTHERS USE. We usually think of transport as a tangible good, but it is also often an anti-rival or network good, and far more valuable the more people there are, until congestion sets in.

Your consumption of bike lanes is much more a complement for mine than a substitute. Your presence increases the demand for bike lanes (and thus network coverage – through a politically intermediated process) and spreads the fixed costs of construction across more users (if it were in fact user financed, in practice it is a

complement because of lobbying the government, but that's another story).

Your consumption of transit is a complement to mine, increasing the likelihood there will be a bus on the route I want to travel, at the time I want to travel, and lowering my wait time. This is dubbed the *Mohring Effect* in transport, named after Herbert Mohring, who identified this in 1972.¹⁶ The basic idea is that if 50 people want a ride each hour, you send one bus. If 100 people want a ride each hour, you send two buses, each a half-hour apart, and the average rider only has to wait half as long, (reducing wait times, and over a network, reducing transfer times) benefiting everyone. Similarly, the more riders, the more spatial coverage that can be provided (reducing access and egress times).

¹⁶ (Mohring 1972).

Even your consumption of driving complements mine where network density is low, ensuring there will be a road network, which I could not afford myself. In short, not only is transport usually non-rivalrous in the long run, it is anti-rivalrous. Even in the short run, significant congestion is the exception not the rule.

ANTI-EXCLUDABLE: I SPREAD THE USE OF THE GOOD TO OTHERS EVERY TIME I USE. But how can such a good be anti-excludable?

We hypothesize the more people who walk, the more likely the next person will be to walk, because walking invites more people to walk, the act of walking acts as an advertisement for the act of walking. Similarly for biking,¹⁷ riding transit, or driving a car. The more you see it, the more plausible it becomes. We feel more comfortable walking the more pedestrians there are. We feel safer walking. We are safer walking.¹⁸ Every pedestrian is a reminder to drivers that there are other pedestrians. Every pedestrian acts as "Eyes on the Street" extending dictum of Jane Jacobs.¹⁹

¹⁷ (Schoner et al. 2016).

¹⁸ (Murphy et al. 2017).

¹⁹ Jacobs originally applied the phrase to local proprietors ensuring safety by keeping eyes on the street for the neighborhood (Jacobs 1961).

The northwest corner of Figure A.4 is standard. Does it make sense to think about the remaining five cells as de Vries suggests?

There are five cells in the table requiring names, we use the following:

- Anti-Rival and Excludable: *Hub Good*. For example, Facebook, which is excludable, but my membership makes yours more valuable, or an airport hub, or a train station serving multiple lines facilitating transfers.
- Anti-Rival and Non-Excludable: *Media Good*. For example any broadcast activity (de Vries suggests Social Tagging) but really any type of social media like Twitter, which seems to have a hard time keeping people off.

- Anti-Rival and Anti-Excludable: *Memes* or *Memetic Goods*. My possessing an idea does not prevent you from possessing it, so it is certainly non-rival. Unlike tangible property, ideas cannot be easily protected. (There are of course patents and copyrights, but those affect physical (or electronic) production, not what's in your head). However many ideas are better if more people possess them, so we could class them as network goods, or anti-rival. Similarly many ideas are so good people want to share them. Like a juicy secret, telling someone induces it to spread more widely, making it anti-excludable.²⁰ Perhaps Walking or Biking also fall here.
- Non-Rival and Anti-Excludable: *Viral Good*. For instance as per de Vries, Peer-to-Peer software.
- Rival and Anti-Excludable: *Rally Good*. Envision a rally on a public square (for instance to overthrow a government) which attracts protestors, but does get so crowded people cannot participate.

²⁰ See also (Miller 2016).

B

Network Economies, Supply and Demand

		Supply	
		Upward Sloping (Scale Diseconomies) (Rival)	Downward Sloping (Scale Economies) (Anti-rival)
Demand	Downward Sloping (Network Diseconomies) (Rival)	Market [Net rivalrous]	Utility [Complex, near non-rivalrous]
	Upward Sloping (Network Economies) (Anti-rival)	City [Complex, near non-rivalrous]	Hub [Net anti-rivalrous]

Transport, like many technologies, is subject both to network effects (the more transport there is, the more places which can be reached; the more valuable transport is, the more transport is provided), and diminishing returns (once everywhere is connected, new connections are less valuable than old connections). Different modes in different places are in different stages. Enabling current users to go faster (save time), and farther (get better services) in the same time are both valuable contributions of transport systems. Some projects offer no incremental benefits along these dimensions but offer higher quality in terms of the comfort of travel (think of a crowded subway at rush hour versus being able to find a seat).

This appendix introduces the Market-Utility-City-Hub (MUCH) framework for understanding supply and demand interactions when there are economies of scale and/or network externalities. This has special relevance in transport and urban economics, where both properties are often found. This chapter pre-supposes [excludability](#).¹ One could think about these issues in the realm of non-excludability, and anti-excludability, but that’s for another day.

The [previous appendix](#).² discussed rivalry and anti-rivalry, but

Figure B.1: Market-Utility-City-Hub Classification.

¹ §A.

² §A.

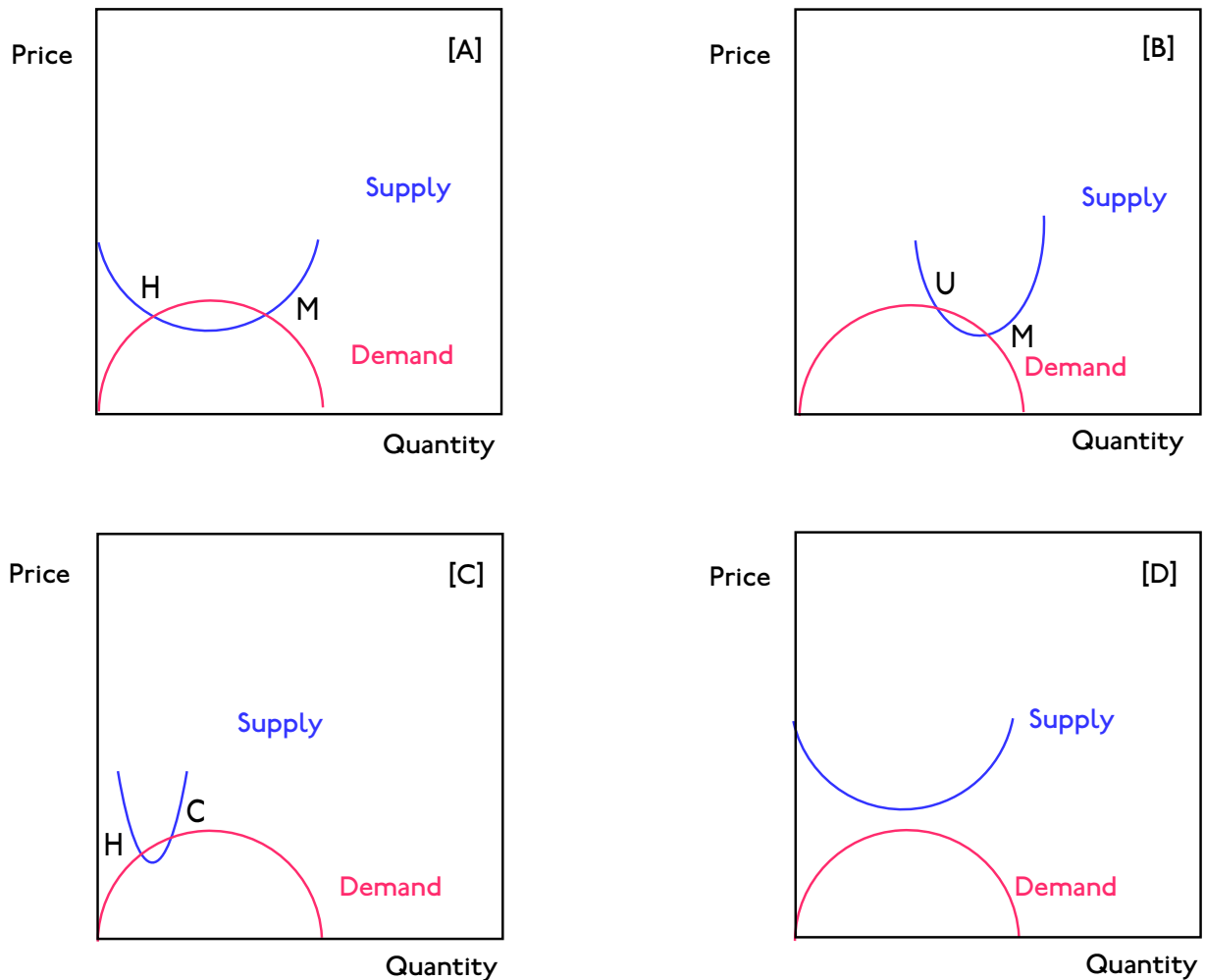


Figure B.2: Market-Utility-City-Hub Supply and Demand.

did not indicate whether those were demand or supply phenomena. In this section, we disentangle the concept of rivalry to its supply and demand elements, as shown in Figure B.1. There are four cases:

- [A] Supply intersects demand twice: when supply is downward sloped and demand is upward sloped (**H**ub), and when supply is upward sloped and demand is downward sloped (**M**arket).
- [B] Supply intersects demand twice: when supply is downward sloped and demand is upward sloped (**U**tility), and when supply is upward sloped and demand is downward sloped (**M**arket).

- [C] Supply intersects demand twice: when supply is downward sloped and demand is upward sloped (**Hub**), and when supply is upward sloped and demand is upward sloped (**City**).
- [D] Supply does not intersect demand.

These cases lead to four types of goods.

TYPE M (MARKET OR PRIVATE) GOODS. Most of introductory economics is explained according to a traditional view of downward sloping demand curves and upward sloping supply curves. As price (on the y-axis) increases, the quantity (on the x-axis) of demand decreases. However as price increases, quantity that is supplied increases, as more suppliers are willing to sell their goods. If an exchange is to be realized, these curves must intersect, which they do in the case of conventional “market goods.” We will call this a type **M** good.

This is shown as the right-side equilibrium in Figure B.2(A) or B.2(B).

TYPE U (UTILITY) GOODS. Economics is far from silent on economies of scale, which are an especially important property in transport economics. Thus we can draw U-shaped supply curves, falling on the left side of the curve, rising on the right. With scale economies, the price per user falls with additional users because the cost structure is dominated by fixed costs rather than variable costs.

Any system with a large physical plant and relatively low unit costs falls into this category. Formally, a natural monopoly is an “industry in which multi-firm production is more costly than production by a monopoly.”³ A public utility is often a natural monopoly. Such sectors are uncontestable in practice, since a new firm would have to duplicate the large physical plant, and has to split customers with incumbents to recover those fixed costs. This is shown as the left-most equilibrium in Figure B.2(B). This is a type **U** good.

³ (Baumol 1977).

While introductory economics assumed a downward sloping demand curve, we might have an apparently upward sloping demand curve. This would give us a parabolic-shaped demand curve, rising on the left, falling on the right. In this case, demand seems to increase with price.

One example of this is a prestige good. Faber College’s education must be better, they charge \$500,000 per year.⁴

Another example is where prices signal something else, our research on HOT lanes showed that people apparently use price as

⁴ Faber College was made famous in the movie *National Lampoon’s Animal House*.

a signal for time savings, and will surprisingly be more likely to use the HOT lane when the price is higher, as they are taking that as an indicator the other lanes are congested (though a higher price, in fact, means the HOT lane has more traffic, independent of the other lanes).⁵

⁵ (Janson and Levinson 2014).

The major case is that of *network externalities* – the more people on the network the more valuable it is, so while the curve is apparently upward sloping, really people are paying a premium for a good with more members. Transport and communications networks have these properties, ranging from telephone systems (which are more valuable if more people have phones) to airlines (which are more valuable to me if they go to more places, which they do because there are more passengers).

TYPE C (CITY) GOODS. Third – we have systems that have network externalities, but without the cost savings of economies of scale. In other words, the economies of scale that exist get fully exploited, and additional users drive up costs. Cities are an example, so we will call this a type C good. The value of a city increases with more citizens, but its costs increase as well due to scarcity of land. Cities will grow so long as the increasing benefits with number of users exceeds the increasing costs with number of users. That is not to say there are no economies of scale and density in cities, for there surely are, but those are part of a lumpy system. So for instance, does multi-story development exhibit economies or diseconomies? On the one hand, the developer only pays for land once, so a high rise achieves economies on land. However, construction costs increase with distance from the ground. Perhaps more importantly, usable space decreases per floor with the height of the building because of elevator shafts. A building that can be served by a single elevator loses one elevator shaft of space per floor. Once the building requires a second elevator, every floor loses an additional shaft of space. For a 20 or 30 or 50 or 100 story building, this is non-trivial. The Empire State Building has 73 elevators. This is the right equilibrium in Figure B.2(C).

TYPE H (HUB) GOODS. Finally, if we have both economies of scale or density and network externalities, we have a system that can get very large. All of the world's successful networks are examples: telephone, internet, social networks, the airline system and so on. In the long run, free market competition or even contestability is likely to be insufficient to enforce good behavior on the owners of such Hub networks, who are likely to charge more than is welfare

maximizing in order to achieve high profitability. Hence regulation, or even public ownership, is often used. This is the left equilibrium in Figures B.2(A) and (C). Call this a type **H** good.

There are of course many things which, with current technologies and preferences, no-one is willing to pay enough, or the cost is too high, to profitably supply. Space travel is an obvious example. This is shown in Figure B.2(D).

It is arguable whether the left equilibria are stable, and the right equilibria generally produce more social welfare. If we are at a right equilibrium, the benefits from the scale economies and network externalities may have been fully exhausted.

C

The Price of Privacy

A concern that arises with many road pricing proposals is government tracking. While we are personally of the belief we don't really have privacy anymore (certainly no one with a smart phone does),¹ we can understand the desire to at least make it more difficult to track travelers. Installing devices in vehicles as a government mandate is not reassuring to anyone, tin-foil hat wearing or not.² To be adopted, policy has to respect that.

There are technical solutions to privacy issues, but implementing these, in the face of the desire of security agencies to be able to track individuals, will be difficult. It may turn out with cameras, mobile phones, and other devices, we lose privacy about our whereabouts well before road pricing is implemented. The solution may be, as David Brin suggests, a *Transparent Society*,³ where everyone can watch everyone, the state does not have a monopoly on monitoring. Based on historical experience,⁴ implementing tolls on existing untolled roads is likely to be politically difficult and unpopular. A 2007 petition in the UK to then Prime Minister Tony Blair beseeched:

"The idea of tracking every vehicle at all times is sinister and wrong. Road pricing is already here with the high level of taxation on fuel. The more you travel - the more tax you pay.

It will be an unfair tax on those who live apart from families and poorer people who will not be able to afford the high monthly costs.

Please Mr Blair - forget about road pricing and concentrate on improving our roads to reduce congestion."⁵

This petition to scrap "the planned vehicle tracking and road pricing policy" was signed by more than 1.8 million UK residents by 2007, more than any other petition in history. It clearly informed the following Prime Minister David Cameron's proposed policy.

Suppose we increase the gas tax to the desired peak hour rate. *This is the politically difficult part.* We then offer a discount for off-

¹ See (Valentino-DeVries et al. 2018).

² Many of the concerns about red light cameras are about privacy, rather than road safety.

³ (Brin 1998).

⁴ (Levinson 2002).

⁵ The petition, now closed, can be found at <http://petitions.number10.gov.uk/traveltax>.

peak travel. This discount requires voluntarily installing in a device in the vehicle which tracks when it is in operation, and the odometer reading. (Not where, just when). For each hour of travel during the peak, travelers have already paid the peak rate. For each hour of travel in the off-peak, travelers get an off-peak discount.

People who wanted to keep their privacy would not install the device. Privacy is not costless.

The device of course makes the system somewhat more complicated than today's gas tax regime, but these are standard devices, already issued by insurance companies offering good driver discounts. Altogether, some complication is unavoidable if when adding a time dimension to the prices charged to travelers.

This system might raise less money than expected if everyone installed the device and people respond to incentives and change behavior. Based on experience with changes in gas prices, we expect those changes are relatively small (the elasticity of demand with respect to gas price changes is pretty low). Further, not everyone will install the device. But changes don't have to be large to have an effect, and we don't want them to be too large (otherwise the peak is uncongested and the off-peak is congested). We could come up with rate schedules that would be appropriate, and might have different rates at different times (such as peak-of-the-peak, shoulder, mid-day, and off-peak).

Another objection is out-of-state travel. Here, we are simply computing when travel occurs and assuming all fuel is purchased in the home state. If every state were to have such a system, this probably has very small boundary effects. If one small state adopts this, and its neighbors don't, some residents might travel out of state to purchase fuel (leading them to not adopt this). Again, we suspect the losses will be small, though they may be measurable. There could either be a federal mandate for such a system (which presents the risk of locking-in a poor standard), or evolution towards an agreement among the various states to coordinate the pricing mechanism. If the differences in peak and off-peak rates were small, they would not distort behavior much, and that might be the best way to implement such a system initially, and then the differences can be increased over time: peak prices increasing, off-peak decreasing, until the desired load balance was achieved.

D

Governance and Performance

D.1 Introduction

The United States is a policy laboratory with 50 states that differ in how they administer roads, and in the performance that results. This appendix examines how road performance varies with governance and organizational structure. It aims to provide some insight or perspective on how roads might be better managed. The hypothesis is that state Departments of Transportation (DOTs) that operate in a more independent manner will have better performance. If this is borne out, it provides preliminary support for reconsidering the relationship of DOTs to state government.

The next section discusses the Governance of state Departments of Transportation. Then measures of performance of state highways are presented. This is followed by a statistical analysis of the performance of state highways from both a financial and systems performance perspective. The research concludes with implications for state DOTs.

D.2 Governance

The governance of state Departments of Transportation in the United States can be characterized across several dimensions. These include organizational leadership, administrative structure, and institutional model.

Organizational leadership

In general, there are two models of organizational leadership which we find in the transport sector:

- the individual; and

- the collegial body (a board or commission composed of multiple members)

The board's membership is often sought out to represent different areas of expertise, or different spatial units (such as Congressional Districts). These both aim to ensure multiple ideas are heard and to account for different interests. Making sure money is spent proportionately across the state is an important political consideration for state governments. Multiple actors inherently slow down decision making compared to a single actor, but help confer legitimacy to decisions. The single actor can be nimbler, and more consistent, but as a result the system may also be more vulnerable to criticism, and its leadership may have a faster turnover. This has the merits of leading to the ability to correct bad policies and poor leadership, but that faster turnover may make it difficult to steer the course. This is particularly a concern for an infrastructure organization or utility, which has a relatively long time frame (projects which take years to deliver and which last for decades) compared to most businesses.

Which mix of board and individual body produces the best results requires comparison of alternative models. It is typical for organizations like corporations to have both a Board of Directors, responsible for larger strategic decisions, and an Executive (for instance a CEO) responsible for daily tactical decisions. Most US State DOTs have a single executive, without a strong board, responsible to a governor (and confirmed by a legislature, which in some senses acts as the Board). Some state DOTs do have Boards though, and their political strength varies on a case-by-case basis. The line between what constitutes strategic vs. tactical decisions varies on a case-by-case basis. The US leadership models, ascertained by reviewing the public web sites of all 50 US state Departments of Transportation, are summarized in Table D.1, it should be noted that there is considerable overlap, for instance a state may have both a strong commission, and a director or commissioner appointed by a Governor.

The Strong Commission states are: Arkansas, Colorado, Florida, Georgia, Idaho, Iowa, Massachusetts, Michigan, Mississippi, Missouri, Nevada, New Mexico, North Carolina, Oklahoma, Oregon, South Carolina, Texas, Virginia, Wyoming.

The Advisory Board states are Arizona, California, Connecticut, Hawaii, Montana, Nebraska, Pennsylvania, South Dakota, and Washington.

Issues in the governance of some states are illustrated below.

Leadership structure	Number of States
Director apptd. by Governor	42
Advisory Board	9
Strong Commission	19
Cabinet	43
Subcabinet	1
Executive Director	10

Table D.1: Leadership organization of state DOTs.

ARIZONA. Arizona has a State Transportation Board, appointed by the Governor, which has final say on policy decisions and financing, and which ultimately serves as an Advisory Board of Directors for the Arizona Department of Transportation (ADOT). Not in the 'Strong Commission' Category, the Director of the ADOT is responsible for administering the department. Members of the Board are appointed from districts, and so represent local issues in addition to statewide.

Arizona is one of the few (if not the only) state to have ever developed a corporate-style financial analysis.¹ The analysis considers not only the normal expenses of maintaining and operating roadways, but also considers depreciation (or construction recovery) costs, so that the long-term expenses are also accounted for. This was the largest cost category. Questions arise in this kind of analysis about the lifespan of the capital investments (the authors assumed 20 years) and the appropriate interest rate (the authors chose commercial rates), though there is no consensus in the literature about how to properly value roads. The authors distinguish earned revenue (i.e. from user charges) from other non-user charge revenue. This analysis shows that Arizona highways were approximately break-even under the then current (1988-1997) inflows and outflows, and thus had less profitability than found in the private sector. It does not appear this analysis has been repeated or is ongoing in Arizona, unlike in Australia and New Zealand.

¹ (Mansour-Moysey and Semmens 2001).

TEXAS. The governance of the Texas DOT is unique in the US. The five Commissioners are appointed by the governor on over-lapping six year terms (the Governor serves a four year term, and is not term-limited). The Commissioners appoint an Executive Director. In Texas, it is said that the Lt. Governor, who presides over the legislature has more power than the Governor.²

² (Lisher 2011).

Concerns about the concentration of power are part of the reluctance to follow the standard US cabinet system. Texas has a

sunset bill that requires periodic reconsideration of government agencies. The Texas House authorized a reexamination of TxDOT after 4 years instead of the usual 12. However, there was also reluctance to make the Transportation Commissioner elected.

³ The unsuccessful proposal to eliminate the Transportation Commission from the Texas Sunset Advisory Commission was recommended on a 7-5 vote.

⁴ (Wear 2011).

In 2011, the Texas legislature considered, and rejected, proposals from the Texas Sunset Advisory Commission³ to replace the five-member Texas Transportation Commission with a single member, both existing and rejected plans would retain appointment by the governor.⁴ A proposal to elect the Commission was also defeated. However, having the lieutenant governor appoint one, and the governor to select one commissioner from a list by the Texas House Speaker was approved.

MASSACHUSETTS. The Massachusetts DOT was radically reformed due to a 2009 law addressing failures of governances associated with the Turnpikes, the Big Dig, and the general poor condition of transport in the state. The Secretary of Transportation, pitched as a CEO, reports to a five-member Board of Directors, and the Transportation Department includes the Registry of Motor Vehicles.⁵

⁵ (Giglio 2011).

Administrative structures

Within a transport department, there are a variety of administrative structures. Many departments are divided into spatially distinct Districts. Further, the departments have a variety of functional structures.

⁶ (Fazzalaro 2007).

State transportation agencies can be classified as follows:⁶

- Agencies Organized by Functional Activity (22 States): Alabama, Arkansas, California, Colorado, Florida, Iowa, Kansas, Kentucky, Louisiana, Maine, Minnesota, Mississippi, Missouri, Nebraska, Nevada, New Mexico, New York, South Carolina, South Dakota, Tennessee, Vermont, and Wisconsin
- Agencies Organized by Transportation Mode (16 States) Arizona, Connecticut, Hawaii, Idaho, Illinois, Maryland, Michigan, Montana, New Hampshire, North Carolina, Oklahoma, Oregon, Pennsylvania, Texas, Washington, and West Virginia
- Agencies With No Readily Identifiable Public Transportation Component Unit (5 States) Alaska, Indiana, North Dakota, Utah, and Wyoming
- Multi-Agency Organizations (7 States) Delaware, Georgia, Massachusetts, New Jersey, Ohio, Rhode Island, and Virginia

Functional activity - based organizations have units for activities like administration, finance, planning, engineering, operations, and construction. Modal-based organizations are typically multi-modal organizations, considering highways and at least one other modal function (public transit, ports, rail, airports, motor vehicles, etc.). Whether the Department that concerns itself with motor vehicle and driver licensing is a police function, a transport function, or independent depends on the state.

Institutional model

In contrast with leadership and administration, which describe how the organization is managed internally, the institutional model considers the placement of the organization within a wider context.⁷ Consider four institutional models: the traditional department, output-based management, an effective road fund, and the public utility model (see Figure D.2). While the US is generally in the camp of “traditional department”, and New Zealand “effective road fund”, Australia was somewhere in between, and does not achieve the same level of independence accorded a public utility.

⁷ (Abrams et al. 1998).

There isn't any variation across US states, so this cannot be considered in further analysis.

D.3 Performance of state highway systems

Every year, the Reason Foundation releases a report on the Performance of State Highway System⁸ using data primarily collected from the states by the Highway Performance Management System of the Federal Highway Administration. In the report, States are assigned ratings based on their financial performance, system performance, and overall performance. The measures are for state-owned highways, and do not include locally-owned roadways, for which there is no national database.

⁸ (Hartgen et al. 2010).

The equations underlying the performance are given in the report, and are repeated here for convenience. This research uses the results of these equations as performance measures in the next section.

System performance

There are seven system “percentage” performance measures (Rural Interstate Poor-Condition Mileage, Urban Interstate Poor-Condition Mileage, Rural Other Principal Arterial Poor-Condition Mileage,

Task	Institutional Arrangement			
	Traditional department	Output-based management	Effective road fund	Public utility
Setting of objectives	Government	Government	Government	Government
Operating environment	Government	Government	Government	Government
Aggregate expenditure	Government	Government	Road fund / Government ^a	Public utility / Regulator ^b
Expenditure allocation	Government	Government/Road agency ^c	Road fund	Public utility
Project appraisal	Road agency	Road agency	Road fund/Road agency ^d	Public utility
Project delivery	Road agency	Road agency	Road agency	Public utility
Charging for road use	Government	Government	Road fund / Government	Public utility / Regulator

^a The government and road fund are jointly responsible for setting road user charges and the revenue collected will influence aggregate expenditure levels over the long run.

^b The prices charge for road use by the utility are subject to regulatory oversight which will influence aggregate expenditure over the long run.

^c The agency is paid to produce a range of outputs (projects) but has autonomy in how the revenue is allocated subject to the constraint that it must produce the agreed outputs.

^d The road controlling agency is primarily responsible for project appraisal but is subject to audit of its appraisals by the road fund.

Table D.2: Responsibility for undertaking key road provision tasks. Source: Table 4.1 in (Abrams et al. 1998).

Urban Interstate Congestion, Fatality Rates, Deficient Bridges, Narrow Lanes on Major Rural Roads)

$$R_{is} = \frac{M_{is}}{\bar{M}} \quad (\text{D.1})$$

where:

R_{is} = Performance Ratio for measure i , state s .

M_{is} = Measure i for state s (such as, % of rural Interstates in poor condition, for North Carolina)

\bar{M} = the weighted average of M_{is} across the 50 states.

Financial performance

The measures for the the four “per-mile” financial measures (Capital and Bridge Disbursements, Maintenance Disbursements, Administrative Disbursements, and Total Disbursements) are adjusted for average width:

$$R'_{is} = R_{is} \left(\frac{L_s}{\bar{L}} \right) \quad (\text{D.2})$$

where:

L_s = the average SHA lanes-per-mile for measure i for state s ,

\bar{L} = the weighted average of the lanes-per-mile, over 50 states.

Overall performance

Overall performance is an average of all 11 measures.

$$\text{Grand Performance Ratio for state } s = \left(\frac{1}{11} \right) \sum_{i=1}^{11} R'_{is} \quad (\text{D.3})$$

This research uses both the relative measures (i.e. normalized to be per mile, or scaled to the national average), and the underlying measures (in unnormalized form) in the next section, to identify what explains differences across states.

D.4 Analysis

The first question is whether there are differences between states based on organizational form. To do this, we take the mean of the Overall, System, and Financial Performance measures across the key organizational structure variables. After exploratory work, the explanatory variable that shows the most promise is Commission-led vs. Secretary-led states.

In the commission-led states, the Secretary or Director of the state Department of Transportation reports to a Commission. In the Secretary-led states, the Secretary of DOT reports directly to the Governor (except in California, where there is a more hierarchical organization).

Recall that a lower performance score indicates better system performance or lower expenditures per mile. The results are shown in Table D.3. In all three cases, the performance of Commission-led states is better than that of Secretary-led states, the differences are statistically significant.

While this measure is suggestive, there may be some other underlying difference which explains this. For instance,

Table D.3: Difference of means test of system and financial performance.

	Mean	Std Dev	N	T-Test
Overall Performance				
Secretary-led	1.26	0.137	31	11.91
Commission Led	0.886	0.0669	19	
System Performance				
Secretary-led	1.19	0.157	31	9.88
Commission Led	0.834	0.077	19	
Financial Performance				
Secretary-led	1.36	0.179	31	7.46
Commission Led	0.978	0.172	19	

expenditures may be lower in rural states because of the different nature of road use, and rural states may be more likely to have commissions as their governance changes more slowly (and commissions were traditional a century ago). In order to control for these additional factors, we conduct a statistical regression to control for multiple factors simultaneously.

We can model the expenditures on highways as depending on two key factors, the prices or costs of inputs and on the amount of outputs (travel) on those highways.⁹ This can be expressed as below:

⁹ (Levinson and Gillen 1998).

$$M = f(P, Y) \tag{D.4}$$

where:

M = Performance Measure (such as Expenditures for Financial Measures and Pavement quality for System Performance).

P is a set of prices for (such as indicators for the cost of capital and labor)

Y is a set of outputs (such as VMT)

Here we estimate such a model with current data for expenditures (which are the key factors in Financial Performance). We also predict measures which describe System Performance.

The hypothesis being tested is whether organizational structure affects performance. In particular, we want to know whether having a strong Transportation Commission governance has better performance than states without strong commissions.

We develop several variables to test this hypothesis. The first is we interact VMT with two dummy variables, one for commission-led states (*Commission*[1,0]), the other for secretary-led states (*Secretary*[1,0]).

$$VMT_{secretary} = VMT * Secretary[1,0]$$

$$VMT_{commission} = VMT * Commission[1,0]$$

Salary is the average state salary, from the Bureau of Labor Statistics (all professions), which is aimed at providing a price index for the cost of labor in the state.

S&P Rating is the bond rating of the state from Standard and Poor's Bond Rating Agency converted to numerical form: AAA = 3, AA = 2, A = 1. The Bond Agency uses + or – on top of the letters. Here it is coded so that a + adds 0.333 and – subtracts 0.333. So for instance AA+ = 2.33, AAA- = 2.67. This is in a sense inversely related to the cost of capital, since states with high bond ratings have lower interest rates.

RuralShare = $\frac{VMT_{rural}}{VMT}$. This is included to account for differences in states with a predominantly rural road network with urban states. Rural states have more center line miles that need to be maintained, but also have less traffic per mile, changing the mix of services they provide. This is intended to account for other spatial differences in that rural states are more likely to have Transportation Commissions rather than Secretaries leading the Departments.

Other variables were tested in preliminary analyses, and later dropped as being statistically insignificant and economically inconsequential. These included weather variables (Mean January Temp, Mean July Temp, Precipitation Inches, Precipitation Days, Snow Inches), other institutional structure variables (Presence of a Weak Advisory Board), administrative structures (Internal Classification of State DOT as Functional, Modal, No Public Transit, or Multi-Agency), and whether the state is an advanced user of Performance Measures according to the Pew Center on the States.¹⁰

The models are estimated in Cobb-Douglas (ln-ln) functional form, which in general improved fit against linear forms. Given the sample size (50) and the nature of the cross-section, more complex functional forms were not seen as significant improvements.

Examining first disbursements (Table D.4) the four columns represent Total disbursements, Administrative disbursements, Maintenance disbursements, and Capital and Bridge disbursements. All values are in dollars. We see that VMT is an important predictor in all four cases. In three of the four cases, the coefficient on VMT in secretary-led states is higher than the coefficient on VMT in commission led states. This means those states had more expenditures per vehicle mile traveled. Only for maintenance disbursements was the coefficient VMT higher in commission led states. However the differences between the two coefficients are not statistically significant.

¹⁰ (Pew Center on the States and The Rockefeller Foundation 2011).

	Total		Admin		Maintenance		Capital and Bridge	
<i>VMT_{secretary}</i>	0.832 *** (0.05)		0.81 *** (0.103)		0.72 *** (0.086)		0.92 *** (0.058)	
<i>VMT_{commission}</i>	0.826 *** (0.048)		0.80 *** (0.098)		0.73 *** (0.082)		0.90 *** (0.055)	
<i>Salary</i>	1.03 * (0.555)		1.96 * (1.132)		2.42 ** (0.948)		-0.50 (0.639)	
<i>S&PRating</i>	0.15 (0.18)		-0.07 (0.368)		0.08 (0.309)		0.08 (0.208)	
<i>RuralShare</i>	-0.02 (0.124)		0.06 (0.253)		0.45 ** (0.212)		0.09 (0.143)	
<i>Constant</i>	-5.56 (5.818)		-10.61 (11.866)		-13.62 (9.947)		16.10 ** (6.706)	
Adjusted R^2	0.8827		0.6436		0.6433		0.8533	

Notes: Beta coefficients given. (Number in parenthesis indicates standard error). Explanation of variables in text.

* = variable is statistically significant at $p < 0.1$ level,

** = variable is statistically significant at $p < 0.05$ level,

*** = variable is statistically significant at $p < 0.01$ level.

Table D.4: Regression models of disbursements. Disbursements in dollars. All Variables in natural log (ln) form.

Disbursements per se are neither good nor bad, nor necessarily efficient or inefficient. However producing one vehicle mile for less money, all else equal, is efficient. We only can determine whether all is equal in the context of outcome measures, shown on the next two tables.

Examining next pavement condition (Table D.5), we see that VMT is insignificant for both rural and urban Interstates, and a negative predictor for pavement condition on rural other principal arterials. The magnitudes are almost identical across commission and secretary states in all three cases. States with high salaries have worse pavement (more pavement in poor condition), and states with better S&P ratings have better pavements. States with more rural traffic have more rural pavement in poor condition.

	Urban Interstate	Rural Interstate	Rural Arterials	
$VMT_{secretary}$	-0.513 (0.922)	0.4249 (0.402)	-1.168 (0.293)	***
$VMT_{commission}$	-0.509 (0.881)	0.4247 (0.384)	-1.171 (0.28)	***
$Salary$	10.75 (10.124)	12.63 (4.415)	1.49 (3.225)	***
$S\&P Rating$	-9.73 (3.299)	-5.46 (1.438)	-0.87 (1.05)	***
$RuralShare$	0.25 (2.267)	1.87 (0.988)	-1.11 (0.722)	*
$Constant$	-95.83 (106.134)	-130.67 (46.283)	-2.88 (33.806)	***
Adjusted R^2	0.1362	0.3282	0.241	

Notes: Beta coefficients given. (Number in parenthesis indicates standard error). Explanation of variables in text.

* = variable is statistically significant at $p < 0.1$ level,

** = variable is statistically significant at $p < 0.05$ level,

*** = variable is statistically significant at $p < 0.01$ level.

Turning to other performance measures (Table D.6). We see that VMT is an important predictor of percentage of narrow lane roads (more VMT, more narrow lane roads), percentage of structurally deficient and functionally obsolete bridges (more VMT fewer poor bridges), and urban Interstate congestion (more VMT, more congestion). In all three of these cases, commission-led states had a lower rate of the poor performance than secretary-led states. The only significant predictor of fatal accident rate was salary, states with higher salaries had fewer crashes.

In short, in eight regressions where the VMT was statistically significant, commission-led states had lower disbursements or better performance in seven of eight cases. The likelihood of at least seven of eight cases turning out this way (assuming that in fact the two numbers were equal, i.e. applying the binomial theorem with

Table D.5: Regression models of pavement condition. Percent poor pavement condition. All variables in natural log (ln) form.

	Lane Width		Crash Rate		Bridges		Congestion	
$VM_{T_{secretary}}$	3.47 *		0.01		-2.27 *		11.14 ***	
	(1.908)		(0.037)		(1.327)		(2.402)	
$VM_{T_{commission}}$	3.21 *		0.02		-2.47 *		11.03 ***	
	(1.824)		(0.035)		(1.268)		(2.296)	
<i>Salary</i>	24.18		-2.02 ***		-9.77		-2.07	
	(20.945)		(0.41)		(14.565)		(26.369)	
<i>S&P Rating</i>	0.26		-0.20		0.12		-1.75	
	(6.825)		(0.133)		(4.746)		(8.593)	
<i>Rural Share</i>	7.42		0.05		-7.92 **		-15.59 **	
	(4.69)		(0.091)		(3.261)		(5.905)	
<i>Constant</i>	-274.46		22.79 ***		144.89		-69.67	
	(219.562)		(4.302)		(152.681)		(276.422)	
Adjusted R^2	0.0036		0.5636		0.1032		0.5277	

Notes: Beta coefficients given. (Number in parenthesis indicates standard error). Explanation of variables in text.

* = variable is statistically significant at $p < 0.1$ level,

** = variable is statistically significant at $p < 0.05$ level,

*** = variable is statistically significant at $p < 0.01$ level.

Table D.6: Regression models of other measures. All Variables in natural log (ln) form.

$n = 8$ and $p = 0.5$) is 3.5 percent, giving us confidence that the differences in the aggregate are meaningful.

D.5 Conclusions

This appendix examined the governance structure of American state Departments of Transportation, and used governance structure to explain differences in financial and system performance. Governance structure in terms of organizational leadership, whether the DOT was led by a Secretary who reported to the Governor or led by a Commission proved to explain some differences in performance. Commission-led DOTs were less costly in terms of expenditure per vehicle mile traveled and had better performance in

terms of pavement quality, lane width, percent of bridges in poor condition, and urban area congestion that were secretary-led DOTs.

This gives us some hope that organizing transport agencies so that they report to commissions rather than directly to a Governor can somewhat affect priorities within the agency and its resulting performance. This also provides some preliminary evidence in support of prospective Road Enterprises.

As proposed in ¹¹, Road Enterprises have a set of key features, among them are political independence, management led by a governing Board who can hire and fire a chief executive officer and makes important strategic decisions, and financial independence. No DOT in the US has financial independence. Unlike turnpikes or public utilities, they cannot raise rates with the approval of an independent commission, but instead can only raise gas taxes with the approval of the state legislature. Political independence and good management have a wider spread among US organizations. While no state DOT in the US achieves full Enterprise status, Commission-led DOTs are closer, as they have the Board-Executive model in place. Commission-led DOTs are more likely to view the mission of transport provision differently than those where the Secretary reports to a governor. They have more independence than secretary-led organizations, and a better management model with an executive reporting to a board.

¹¹ Levinson, D. M.

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Long-Range Funding Solutions

On June 24th, 2009 the Minnesota Department of Transportation held a “Long-Range Funding Solutions Symposium” to examine issues associated with the long-term funding of transport. This kind of event is common in the transport community. David Levinson made the following remarks (edited for clarity).

MnDOT identified \$50 billion of unfunded ‘needs’ for additional resources of which 86% are for the purpose of ‘mobility’ over the next 20 years. I am not clear as to how these needs were identified, but several points should be kept in mind. First, this is a slow-growing region (and outside the Metro a declining state). It has 5 million people now, and at best is growing at about 1 percent per year. Second, per-capita Vehicle Miles Traveled has been flat for almost a decade, and overall VMT growth has been flat for about half a decade. There are several reasons for this, most recently recession and high gas prices, but the most important is market saturation. If speeds are not growing (because we have maxed out the network given current technologies and face diminishing marginal returns to new road construction), and people have finite time, they choose not to devote additional time to travel (and thus distance). Fortunately, since the I-35W Bridge Collapse, MnDOT has adopted a “fix it first” approach, so that system preservation, operations, and maintenance get the largest share of the existing budget, and comprise the first funded element of needs.

We cannot know what ‘needs’ for mobility are if we have an unpriced (or underpriced) transport system. People will always over-consume if they are subsidized, and people do not presently pay for the congestion externality they impose on others. Once we have something like marginal cost pricing (or a second-best version thereof), we can determine which links generate more revenue than they cost to operate and maintain, and that will signal where capacity should be added, where the benefits of added capacity outweigh the costs.

Another way of thinking about what \$50 billion means is that Minnesota is a state of 5 million people, so that amounts to \$10,000 of new construction for each resident of Minnesota (because this is

above and beyond the funded part which takes care of preservation (we hope)). Over 20 years, \$10,000 per capita is \$500 per year, or about \$0.50 per round trip. But that \$0.50 per trip is not to pay for existing infrastructure, that is to pay for new infrastructure those travelers may or may not use; or if we were to charge users, we would be looking at 10 to 100 times as much per trip, as the new capacity built for \$50 billion will serve only 10% to 1% of trips, most trips will continue to use pre-existing infrastructure.

We could also talk about mobility vs. accessibility, and why is it important to enhance mobility, but that is another long discussion, refer to the Access to Destinations study for details.¹

¹ (El-Geneidy and Levinson 2006).

Attention is a scarce resource, spending time on non-starters like \$50 billion in 'mobility' needs detracts from real problems with existing infrastructure.

In short, the \$50 billion suggested comprises 'Wants' not 'Needs.'

Second, we need to re-examine the institutional structure of transport funding and administration. We should consider a public utility model where a transport authority or utility with independence from the legislation and executive branch of government determines how much is required to maintain (and as necessary expand) the transport system, with oversight from a Public Utility Commission or similar. This would resemble how natural gas and electricity and water and sewer in many places are currently delivered. Like those, transport is a utility that has costs that users should bear as directly as possible. The user fee notion would be embedded into the governance structure of such a transport authority. The British might call this a Transport Trust. We could consider how this is organized at different levels of government (keeping state and local separate or bringing them together?)

² §16.

Third, [value capture](#),² has not been fairly characterized in the presentation made today. If we do not have road user fees, transport creates value for land-owners.³ Since we do not have road user fees, value is created. Several of the methods proposed by the value capture study hold promise for financing transport systematically, not just at the project level.

³ If we do have marginal cost user fees, a closed system, and invest the revenue in transport, making some simplifying assumptions, we would not have additional land value associated with investment (in the absence of [agglomeration economies](#))(§12.)

Fourth, in the short-term (next decade or so), [gas taxes](#),(§3). indexed and adjusted appropriately should be used to fund transport, as they are administratively much more efficient than road user charges. They have several advantages: foremost they are cheaper to collect than most of the proposed VMT charges. An annual odometer reading is certainly a similar alternative, but that does not have the environmental benefits of discouraging motor fuel consumption and encouraging better mileage. Ultimately as the fleet becomes electrified, the gas tax becomes a better and better incentive to move in that direction. If today 100% of the drivers use gas and pay for 100% of roads (which I recognize is not strictly the case at the state level, but is simply illustrative), and next year only 50% of drivers used gasoline, the remaining 50% would pay for all of the roads by doubling the gas tax. That provides a somewhat stronger incentive to switch to electricity. If the following year another 25% switch to

electricity, than 75% use electric and 25% use fuel and pay the motor fuel tax, which is now 4 times as high. Eventually this becomes unsustainable as the last drive of a gasoline-powered car could not possibly afford 100% of the road system's costs, but in the meantime the incentive works in the right direction for the environment, and since government is always a lagging indicator, retaining the gas tax for as long as tenable should be considered the near term solution, with continuing research into road pricing, additional demonstration, and deployment of select strategies like high-occupancy/toll lanes.

Fifth, cities, regions and states have turned to [voter referenda](#)⁴ and propositions in many places where these are allowed. Voter referenda typically ask voters to approve a sales tax increase to support a variety of road and transit projects over a period of decades. These referenda can be interpreted as a response to the reluctance of elected officials to raise fuel taxes. For whatever reason, voters see widely shared sales taxes as more acceptable than targeted user fees, even though sales taxes can often be regressive (though actual regressivity can only be determined after the money is spent).

⁴§17.5.

At any rate, as I have learned today, in Minnesota transit funding depends on the Motor Vehicle Sales Tax, so I will do my part to help fund transit and buy a car.

Postscript: Homo Gridicus

Announcer: We now return to *Knightboat: the Crime-Solving Boat*.

Michael: Faster, Knightboat! We gotta catch those starfish poachers.

Knightboat: You don't have to yell, Michael, I'm all around you.

Michael: Oh, no! They're headed for land.

[the poachers ride onto the beach, jump on motorcycles, and speed away]

Michael: We'll never catch them now.

Knightboat: Incorrect: look! A canal.

Homer: Go, Knightboat, go!

Bart: Oh, every week there's a canal.

Lisa: Or an inlet.

Bart: Or a fjord.

Homer: Quiet! I will not hear another word against the boat.⁵

⁵ (Crittendon 1995).

To achieve the libertarian, survivalist, and anarchist dream of purely autonomous individuals acting independently, but still maintaining modern conveniences, many technologies need to be delivered in radically different ways. Our unplugged isolationists could:

- Produce power on-site, without need of a grid, through wind turbines on their own property, rooftop solar, or geothermal.
- Unplug from the telecommunications monopolies through a peer-to-peer internet system, where everyone's WiFi connects to their neighbors.⁶
- Collect and treat rainwater and use that to drink and clean, before discharging gray water onto property, and other waste into a septic system.
- School children at home, or in independent charter or private schools.

⁶See, for example, LifeNet, which provides internet connectivity in disasters through peer-to-peer ad hoc network sharing. <http://www.thelifenetwork.org>.

What is the transport analog? Could our unplugged isolationists effectively avoid the use of roads and still achieve their desired accessibility? Do they even care about access to other people and goods if they are truly autonomous?

⁷ (Hawkins 2018).

The first obvious answer is air transport. All we need are flying cars, autogyros, hovercraft, or helicopters, and who cares about roads – just use the air as a commons. Uber Elevate has released drawing of their potential skyports.⁷ The problem is the much higher energy consumption (and thus cost) required per trip. While for long-distance trips commercial aviation consumes a similar amount of energy on a per-passenger-distance basis as cars, energy consumed will be proportionally much higher for shorter distance trips.

⁸ *Knightboat: the Crime-Solving Boat* was satirizing the 1982-86 TV show *Knight Rider*, about an early intelligent autonomous vehicle.

The next obvious answer is water transport. But we run into the problem identified by *The Simpsons* in the excerpt above.⁸ Inland waterways are much more a tree-like network than a grid, and outside of the *The Simpsons* universe, there is not always a canal.

⁹ §1.1.

In the end, we have to concede a certain impracticality in being ‘off-the-street-grid,’ much as our founding fathers realized in the Postal Clause of the US Constitution, empowering Congress “To establish Post Offices and post Roads.” Adam Smith writing a decade earlier (1776) described the ‘*The Duty of the Sovereign*’,⁹ which included a commitment to roads.

¹⁰ David Levinson quoted (Haugen 2012).

There isn’t a person in the United States who doesn’t get some use out of the roads, Even people who don’t drive still benefit from things like fire protection, ambulance services, and mail delivery – all of which depend on roads. I suppose you could be Ted Kaczynski, but even he had to use the US Postal Service to mail his bombs.¹⁰

We are all Homo Gridicus, a species of networked people. We all want access to something: radical anarchist and anti-technology terrorist Unabomber Ted Kaczynski needed to access his victims.

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